Electronic Engineering

Incorporating . . . ELECTRONICS, TELEVISION & SHORT WAVE WORLD

VOL. 20 No. 250 DECEMBER 1948 PRICE 2/-

A MERRY XMAS

to our many friends AT HOME and OVERSEAS and if possible, better reception in the NEW YEAR

CONDENSERS

TCC	500 pF	350	VD.C. wkg.	Micadisc	CM30	Price each	2/6
,,	0.001 μF	,,	,, ,,	Mica type	CM20N	,,	1/9
,,	0.002 μF	,,	,, ,,	Metalmite	CP30S	,,	1/9
,,	0.005 μF	,,	,, ,,	,,	CP31N	,,	1/8
,,	0.01 μF	,,	,, ,,	,,	CP32N	,,	1/8
,,	0.1 μF	,,	,, ,,	Metalpack	CP45N	,,	2/1
,,	0.1 μF	1000V	,, ,,	,,	CP47W	,,	2/6
,,	0.25 μF	500V	,, ,,	,,	CP47S	,,	2/10
,,	0.5 μF	350V	,, ,,	,,	CP47N	,,	3/0
,,	0.5 μF	500V	,, ,,	,,	CP91S	,,	3/10
,,	1 μF	350V	D.C. peak	Picopack	CE30N	,,	2/6
,,	8 μF	450V	D.C. wkg.	Micropack	CE19P	,,	4/6
Dubilier	8 μF	500V	,, ,,	Drilitic	BR85O	,,	4/0
TCC	16 μF	350V	,, ,,	Electrolitic	CE26L	,,	4/9
,,	20 μF	12V	D.C. peak	Picopack	CE30B	,,	2/6
,,	30 μF	350V	D.C. peak	Electrolitic	CE29L	,,	6/6
,,	32 μF	450V	,, ,,	,,	CE37P	,,	10/0
,,	30-30 μF	350V	,, ,,	,,	CE37L	,,	12/0

SCANNING EQUIPMENT

Scanco Television—scanning coils for 9 in. or 12 in. Magnetic CRT's. Price £1 8 6
Scanco Television—focus coils for 9 in. or 12 in. Magnetic CRT'S. Max. D.C. 40mA ... ... Price £1 11 6
Scanco Television—line output transformer, ratio 4.5 : 1. Max. D.C. 75mA on pri. ... ... Price £1 5 6

RAYMART SHORT-WAVE COILS

Plug-in type wound on RD4 low-loss dielectric formers. Both 4 and 6-pin types being interchangeable with competitive makes.
Coverage with 0.00016μF. Variable condenser.

Type CA	4-pin	11-25 metres	... ...	Price	4/0
,, CB	4-pin	20-45 ,,	... ...	Price	4/0
,, CC	4-pin	44-100 ,,	... ...	Price	4/6
,, CD	4-pin	80-180 ,,	... ...	Price	4/9
,, CA6	6-pin	11-25 ,,	... ...	Price	4/3
,, CB6	6-pin	20-45 ,,	... ...	Price	4/3
,, CC6	6-pin	44-100 ,,	... ...	Price	4/9
,, CD6	6-pin	80-180 ,,	... ...	Price	4/9
,, CE6	6-pin	110-250 ,,	... ...	Price	5/6

TELEVISION & SHORT WAVE COMPONENTS

TRANSFORMERS AND CHOKES

Stewart—350-0-350V, 250mA ; 6.3V, 6A ; 4V, 8A ; 0-2-6.3V, 2A ; 4V3A. Size 4½ × 4½ × 6½ in. Unshrouded ... ... Price £5 5 0
Elstone—MT8. 500-0-500V, 250mA ; 5V, 3A ; 6.3V, 3ACT ; 6.3V, 6ACT. Size 4½ × 4½ × 4½ × 5½ in. ... ... Price £3 7 6
Varley EP56—500-0-500V, 200mA ; 6.3V, 3A ; 5V, 2.5A ; 2-0-2V, 4A. Size 4½ × 5 × 3½ in. Unshrouded. ... ... Price £3 12 6
Stewart—230 volt primary only. Sec. 1750V, 4mA ; 4V, 1ACT ; 4V, 1ACT (for use with VCR97, etc.). Heater insulation equal to full peak inverse. Size 2½ × 2½ × 4½ in. Unshrouded ... ... Price £2 0 0
Scanco—E.H.T. Transformer Pr. 230V. Sec. 4KV, 10mA max. 2-0-2V, 2A. Size 4 × 3½ × 4 in. Vacuum impregnated and full shrouded Price £2 8 0
Scanco—E.H.T. Transformer Pr. 230V. Sec. 5KV, 10mA max. 2-0-2V, 2A. Size 3½ × 4 × 4½ in. Vacuum impregnated and fully shrouded. All leads ceramic bushed ... ... Price £3 0 0
Stewart Smoothing Choke, 5H, 250mA ... ... Price £1 5 9
Stewart Smoothing Choke, 10H, 80mA ... ... Price £0 13 0

VALVES

MULLARD

EB91	B7G based 6.3V double diode for television mixer ...	Price 12/10
EC91	B7G based 6.3V twin triode as USA 6J6	Price 30/5
EE50	Television type electron multiplier. B7G base 6.3V slope 14mA/V.	Price 30/5
EL38	Television Line output valve. Max. output 30V/amperes 6.3V	Price 24/4
EN21	Gas triode for time-base generators. 6.3V max. freq., 175Kc/s.	Price 21/4
EY51	Miniature EHT rectifier. No base. 6.3V, 7KV max at 150 μA.	Price 24/4

MAZDA

Pen46	Television line output valve, max. output 25V/amperes, 4V	Price 18/3
T41	Television thyratron for time-base use. 4V Max. freq. 15 Kc/s.	Price 12/10
6F12	Midget television HF pentode. B7G base, 6.3V heater ...	Price 21/4
6L18	Television local oscillator triode B8A base. 6.3V ...	Price 14/8

RAYMART SHORT-WAVE CONDENSERS

All condensers are microvariable and are of the all-brass construction type, using ball-bearing spindle and ceramic insulation. Single hole fixing and double-ended for ganging purposes.

Type VC	15X	0.023 in. gap.	2.5/15 pF	Price	3/9
,, VC	40X	0.23 in. gap.	2.75/40 pF	Price	4/0
,, VC	100X	0.023 in. gap.	3.8/100 pF ...	Price	5/6
,, VC	160X	0.23 in. gap.	5/160 pF	Price	6/6
,, VC	250X	0.023 in. gap.	7.3/250 pF ...	Price	7/9

RAYMART SHORT-WAVE CONDENSERS

Aerial insulators, type AG. 3½ in. ribbed pyrex glass	Price	1/1
Stand-off insulators, type SX, 3½ in. high (ex-terminals) ...	Price	2/1
,, ,, ,, SM 1½ in. high (ex-terminals) ...	Price	9d.
,, ,, ,, SS 1 in. high (ex-terminals)	Price	7d.
,, ,, ,, ST ½ in. high (ex-terminals)	Price	6d.

KNOBS AND DIALS

Large skirted bakelite knob, with 4 in. graduated metal dial. 0/100 deg. Type TXD ... ... Price 6/6
As above, but with 2½ in. dial, type TXJ ... ... Price 3/11
Pointer knobs, 2½ in. long, type LPK ... ... Price 1/3

MISCELLANEOUS

Two-piece Ceramic feed-through bush, 4BA hole ... ... Price 3½d.
Two-piece Ceramic feed-through bush, 2BA hole ... ... Price 5d.
Feeder spreader. Ceramic, 6 in. wide ... ... Price 7d.
Transposition block in raymex ceramic, 6d. Aerial "T" piece ceramic. Price 1/3

VALVES

807	Power tetrode for transmission and audio work, 6.3V—	Price (Surplus) 7/0 (New) 25/0
954	Acorn "Straight" R.F. pentode wire base, 6.3V	Price 7/6
6J5	General-purpose triode octal base, 6.3V Price (Surplus) 4/6	(New) 9/2
TT11	UHF output tetrode 8 watts at 300 Mc/s., 6.3V	Price 6/0
EP54	UHF R.F. pentdoe max. freq. 275 Mc/s., 6.3V Price	(Surplus) 7/6 (New) 21/4

ALEC Davis SUPPLIES Ltd.

18 TOTTENHAM COURT RD.,

LONDON, W.1. Phone : MUSeum 2453, 4539

SHOP HOURS :

MONDAYS–FRIDAYS 9–5-30. SATURDAYS 9–1.

CLASSIFIED ANNOUNCEMENTS

The charge for these advertisements is twelve words or less 5/- and 4d. for every additional word. Box number 2/- extra, except in the case of advertisements in "Situations Wanted" when it is added free of charge. A remittance must accompany the advertisement. Replies to box numbers should be addressed to: Morgan Bros. (Publishers) Ltd., 28, Essex Street, Strand, London, W.C.2 and marked "Electronic Engineering." Advertisements must be received before the 10th of the month for insertion in the following issue.

OFFICIAL APPOINTMENTS

Vacancies advertised are restricted to persons or employments excepted from the provisions of the Control of Engagement Order, 1947.

THE UNIVERSITY OF SHEFFIELD. Applications are invited for a post of Lecturer or Assistant Lecturer in the Department of Electrical Engineering. Salary scales: Lecturer, £550, rising by £25 every year, to £650; if the appointment is then renewed, £700, rising by £50 every two years, to £800. Assistant Lecturer, £450 a year, rising by £25 a year, to £500, with superannuation provision under the Federated Superannuation Scheme for Universities, and family allowance. The commencing salary on either scale will depend upon the qualifications of the successful candidate. Facilities will be offered for research. Preference will be given to candidates having some experience in electrical communications work. Further particulars may be obtained from the undersigned, with whom applications (four copies), including the names and addresses of three referees and, if desired, copies of testimonials, should be lodged by December, 1948. A. W. Chapman, Registrar.

UNIVERSITY OF BIRMINGHAM Department of Electrical Engineering. Applications are invited for, a post of Lecturer (Grade I) in Electrical Engineering at a salary of £850 to £1,050 per annum, according to qualifications. It is intended that the person appointed will also be appointed Reader in Electro-Magnetism with suitable status. Duties to commence, if possible, by 1st January, 1949. Further particulars may be obtained from the undersigned, to whom applications should be sent within a fortnight of appearance of this advertisement. C. G. Burton, Secretary, The University, Edmund Street, Birmingham, 3.

B.B.C. invites applications for an engineering post in the Acoustics Section of the Research Department at present situated at Balham, S.W.12, and later at Kingston, Surrey. Candidates must possess a University degree in Physics or Electrical Engineering, or equivalent qualifications, such as Graduate Membership of the Institution of Electrical Engineers. The duties consist of research on acoustic design of studios and involve investigation into acoustical properties of materials and structures. A knowledge of Physics and of Electronics is necessary. A good knowledge of Music and some workshops experience would be an advantage. The salary is in a grade with annual increments of £25, rising to a maximum of £580 per annum. Applications, stating age, qualifications and experience, should reach the Engineering Establishment Officer, Broadcasting House, London, W.1, within seven days of the appearance of this advertisement.

B.B.C. invites applications for vacancies in the Television Transmitter Section of the Designs Department. Applicants should preferably have a degree in Electrical Engineering and some experience in modern electronic practice. They should have a good basic knowledge of the theory of electrical networks and a keen interest in circuit designs. The salary is in a grade with annual increments of £30, rising to a maximum of £680 per annum. Applications, stating age, qualifications and experience, should reach the Engineering Establishment Officer, Broadcasting House, London, W.1, within seven days of the appearance of this advertisement.

MINISTRY OF SUPPLY invites applications from Electronic Physicists and Electronic Engineers for posts in the grades specified below in Research and Development Establishments mainly in Hampshire, Worcestershire and Kent. The qualifications required range from Higher School Certificate or equivalent for the Experimental Officer grades to a good Honours degree for the Scientific Officer grades. Electronics experience is essential. Inclusive salary ranges are:—Senior Scientific Officer, £670-£860; Scientific Officer, £480-£620; Experimental Officer, £495-£645; Assistant Experimental Officer, £220-£460. Rates for women are somewhat lower. Appointments are established, but those appointed to Scientific Officer grades carry F.S.S.U. benefits. Opportunities to compete for established posts may occur later. Write, quoting A.161/48/A, to Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, for application forms, which must be returned by 11th December, 1948.

MINISTRY OF SUPPLY invites applications from Chemists or Engineers for two posts as Experimental Officer in a research and development establishment near London. The work involves the design and use of electronic and other instruments required for the investigation of combustion and allied processes. Candidates must possess at least the Higher School Certificate or its equivalent, and have a sound knowledge of Chemistry, combined with engineering experience. Ability to direct industrial staff is essential. Inclusive salary range, £495-£645. Rates for women are somewhat lower. The appointments are unestablished but opportunities to compete for established posts may occur later. There are prospects for advancement in salary up to £895. Application forms obtainable from Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.903/48A.

SITUATIONS VACANT

THE MORGAN CRUCIBLE CO. LTD., Battersea, S.W.11, require a technical assistant aged approximately 25, with B.Sc. (Eng.). Should have some experience of electronic development work. Write, giving details of age, qualifications, experience and salary required to The Staff Manager.

CHEMIST, PHYSICIST OR METALLURGIST required as Deputy to Chief Technician for production, control and development laboratories in the Swindon area. The work is connected with the manufacture and development of radio components such as electrolytic condensers, volume controls, iron cores and ceramic products. Applicants should have a University Degree with several years industrial experience. Salary in the region of £650 to £850 per annum, according to qualifications. Please reply to Box 381, E.E.

RADAR ENGINEERS required to operate from London headquarters for installation and maintenance of marine installations home and overseas. The essential qualifications are: practical knowledge of electronic circuits and equipment, ability to work without supervision after training, and resourcefulness. Initial salary according to experience. Box 342, E.E.

TWO SENIOR DEVELOPMENT ENGINEERS required by well known company in Essex. Considerable experience in theory and design of V.H.F. transmitters up to powers of 200 watts or on V.H.F. receivers are essential requirements. Applications, giving age, qualifications, experience, and salary required, quoting Ref. No. 133, to Box 348, E.E.

DESIGN DRAUGHTSMEN are required by the English Electric Co., Ltd., Stafford, for research and development work on electronic equipment. Applicants must have Higher National Certificate or equivalent and shop experience. Salary according to experience. Send full details to Central Personnel Services, English Electric Co., Ltd., Queens House, Kingsway, W.C.2, quoting ref. DO.25.

RADIO AND ELECTRONIC SENIOR ENGINEER required by leading firm of manufacturers. Applicants must have extensive practical experience in Technical Development of Electronic Equipment, with special knowledge of circuit techniques. Post is within twenty miles' radius of London and is progressive. Recognised qualifications are desirable, but practical ability is the essential factor; age preferably not over 35 years. Fares paid for interview. Salary, approx. £450 per annum, according to qualifications and experience. Written applications, giving date of birth, full details of qualifications and experience, etc., and quoting reference 439M, should be addressed to Regional Appointments Office, Ministry of Labour and National Service, 23, Valpy Street, Reading.

ELECTRONIC ENGINEERS with Honours Degree or equivalent are required for research and advanced development work by the Nelson Research Laboratories, English Electric Co. Ltd., Stafford. Preference will be given to men with sound electrical engineering experience. Salary according to qualifications. Apply by letter to Chief Administration, Nelson Research Laboratories, English Electric Co., Ltd., Stafford, stating age, experience and academic qualifications.

RADIO DRAUGHTSMEN required by large light engineering company situated in North London. Applicants with knowledge of electronics equipment design are preferred, but practical shop and drawing office experience is essential. Write, stating age, experience and salary required, to Box 366, E.E.

SENIOR DEVELOPMENT ENGINEERS required. Must have good technical training, preferably with Honours Degree in Physics or Engineering and Radio Laboratory experience. Able to carry through development, with assistants, to production stage. Salary up to £800, according to qualifications. Apply, in writing, to Personnel Department, Murphy Radio, Ltd., Welwyn Garden City, Herts.

GRADUATE IN ELECTRICAL ENGINEERING required by company in S.E. London, to take charge of work mainly on cable accessories. No previous experience in this field necessary, but a knowledge of high-frequency phenomena and workshop methods desirable. Salary, £500-£700, according to age and experience. Candidates with experience in an industrial electrical laboratory will have preference. Full particulars to Box 386, E.E.

GRADUATE IN ELECTRICAL ENGINEERING or Physics, with radio, required by company in S.E. London, to take charge of a small section designing and building electronic equipment for specialised high-frequency measurements. Experience with circuit techniques for frequencies above 100Mc/s. essential. Salary, £500-£700, according to age and experience. Full particulars to Box 387, E.E.

DEPUTY DIVISION HEAD required for laboratory responsible for development of carrier current telephone and multi-channel telegraph equipment. Replies from those with suitable experience should give qualifications and salary expected. Permanent and pensionable position with good prospects. Bcx 383, E.E.

SIEMENS BROTHERS & CO LTD.., Ref. 715/6, Woolwich, S.E.18, invite applications for posts as Senior Engineers in the line telephone transmission laboratory. Suitably qualified applicants only should write, stating details of experience and salary required.

LOW POWER RADIO TRANSMITTER Design Engineer required. Qualifications, Engineering or Physics Degree or equivalent and industrial experience of transmitter design. Salary according to qualifications and experience. Pensionable position on permanent staff. Box 384, E.E.

ACOUSTIC SPECIALIST required for application of modern electronic technique to development of and measurement on subscribers' telephone instruments. Applicants should have good theoretical qualifications and a desire to apply them in this field. State salary required. Box 385, E.E.

QUALIFIED ELECTRICAL ENGINEER OR PHYSICIST required for leading radio firm in the London area. Must have had several years in responsible position on design of radar equipment. Salary minimum, £800 per annum or more according to experience. Write Box S.5265, A.K. Advertising, 212a, Shaftesbury Avenue, W.C.2.

ELECTRONIC ENGINEER required as Head of Department engaged on the design and manufacture of special-purpose electronic test gear. A suitable applicant must have an Honours Degree in Electrical Engineering or Applied Physics, and wide experience of Electronic Engineering. State age, qualifications, experience and salary required, to Box 392, E.E.

ELECTRONIC ENGINEER OR PHYSICIST for development of micro-wave radio required by large company in the East London area. Suitable applicant should have technical education to Degree standard and experience in development of electronics. Full details, including age and salary required, to Box 388, E.E.

REQUIRED IMMEDIATELY, by a company in the East London area, an Engineer experienced in the design of inductances for radio communication work. Only applicants having considerable experience of the design of R.F. tuned circuits, I.F. transformers, wave filters and similar devices will be considered. This vacancy is in connexion with a long-term project for the development of high-grade communication equipment. State full details to Box 389, E.E.

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CLASSIFIED ANNOUNCEMENTS (Cont'd.)

APPLICATIONS ARE INVITED for vacancies in development and research laboratories. Applicants must have University Degree or equivalent, with experience in instrument and light electrical work. Salary according to experience. Apply, in first instance, to Personnel Manager, Ferranti Ltd., Ferry Road, Edinburgh, 5.

QUALIFIED ENGINEER required for leading firm in London area. Must have had several years' electro-mechanical design experience in electronics. Salary minimum, £650, or more depending on experience. Write, Box S.5272, A.K. Advertising, 212a, Shaftesbury Avenue, W.C.2.

RADIO ENGINEER required for development of methods of testing and measuring U.H.F. valves and T.R. switches. Applicants must be qualified in Physics or Engineering, and must have experience of radio measurements, in the U.H.F. field. Applications to Personnel Manager (CHA), Ferranti Ltd., Edinburgh, 5.

A LARGE CORPORATION requires an Electronic Engineer to take charge of new project. Applicant should have a good degree in Physics, with laboratory or Government Establishment research experience in television or, preferably, radar. Must be good organiser, capable of controlling staff and, in particular, must have practical experience of making circuits work. Should not be over 35 years of age. Substantial salary according to ability, age and experience. Apply Box 397, E.E.

BUSH RADIO LTD. require Engineers for development work in their Test Gear Dept. Application in writing only, stating experience, qualifications, salary, etc., to Labour Manager, Bush Radio Ltd., Power Road, Chiswick, W.4.

PHYSICIST REQUIRED for research on the magnetic properties of powder metallurgy products. Applicants must hold a University Degree and should possess special knowledge of magnetic measurements. The post is in Northamptonshire. Salary according to experience. Write Box 399, E.E.

ELECTRONIC DRAUGHTSMAN required by large manufacturer of radio and allied equipment, situated in the East London area. Suitable applicants should have previous experience of this work and technical qualifications to National Certificate or equivalent. State age, experience and salary required, to Box 393, E.E.

CAPABLE ENGINEER required to take charge of a department responsible for the pre-production development of radio accessories. Degree or equivalent with several years' industrial production experience essential. Box 395, E.E.

REQUIRED FOR SW. ENGLAND, Engineer for design and production of electronic apparatus. Wide knowledge of C.R.T. practice essential. Box 394, E.E.

ELECTRICAL ENGINEER with a good Degree or equivalent, and experience in design and development of electronic equipment, required by NE. London firm. Salary according to ability and experience. Box 396, E.E.

PROGRESSIVE LAMP FACTORY in Yorkshire manufacturing low-voltage electric lamp bulbs and employing about 350 women, require a highly efficient manager; must be very thoroughly experienced, highly qualified and good disciplinarian. Permanent and progressive post for right man. Applicants should state in detail, age, education, qualifications, references and salary required, to Box 398, E.E.

ELECTRONIC CIRCUIT DEVELOPMENT ENGINEER, 25 to 30 years, B.Sc. standard. Previous laboratory experience essential. Knowledge of Servo systems desirable. Must be practical and capable of bringing projects right up to the production stage. Write or phone Furzehill Laboratories Ltd., Boreham Wood, Herts. ELStree 1137.

YOUNG ELECTRICAL ENGINEER, University Degree or equivalent, to undertake development work on high tension X-ray apparatus, London area. Salary according to age, experience and qualifications. Box 400, E.E.

APPLICATIONS ARE INVITED by a company situated within a 25-mile radius of London for the position of Senior Engineer to take charge of a laboratory engaged upon design, development and application of R.F. Heating. Applicants should have an Honours Degree in Science and previous experience of the work upon which the laboratory is engaged. Salary, £700 to £1,000, per annum, according to qualifications. Applications should be addressed to Box 402, E.E.

VALVE ENGINEER. Well-known London firm has a vacancy for an Engineer in the Transmitting Valve Department. Successful applicant must have had practical experience in all branches of the manufacture of valves up to 20 KW of anode dissipation, and must be capable of conducting and supervising development of new types. Some experience of circuitry an asset. Write, with full details of qualifications and experience, to Box 401, E.E.

E.M.I. ENGINEERING DEVELOPMENT offer outstanding opportunities for experience and advancement in development work in many branches of electronic engineering, including major radar projects, radio communication, television receivers, audio-frequency engineering, magnetic recording, etc. Applications will be welcomed from men with Engineering or Physics Degrees or the equivalent, with design experience. Starting salaries, £400 to £800, according to qualifications, experience and degree of responsibility. Also Juniors for the same work, with Inter.B.Sc. and preferably some practical experience. Send full details of experience and qualifications to Personnel Department, E.M.I. Ltd., Blyth Road, Hayes, Middx.

GLASSBLOWER required for Research Laboratories. All-round experience in hard and soft glasses, including lathe work, essential. Apply in person, or write to Personnel Department, E.M.I. Ltd., Blyth Road, Hayes, Middx.

EXPERIENCED SENIOR and junior radio, television, electronic, acoustic engineers. Preference B.Sc., H.N.C., also similarly experienced draughtsmen. Television Service Engineers required. Technical Employment Agency, 179, Clapham Road, S.W.9. BRIxton 3487.

APPLICATIONS ARE INVITED from Engineering and Physics Graduates and from Designer-Draughtsmen with a Degree or equivalent qualifications by the Research Laboratories of the General Electric Co. Ltd., East Lane, North Wembley, Middlesex, for work on telecommunications equipment. Experience of pulse and wave-form techniques an advantage. Apply to the Director, stating age, academic record and experience.

PHYSICAL CHEMIST OR PHYSICIST, with Honours Degree, required as Chief Technician to take charge of a production control and development laboratory of a company in Wiltshire, manufacturing radio components. Research and industrial experience are essential. The post carries a good salary, and a house will be provided for the successful applicant after a three months' probationary period. Please reply to Box 404, E.E.

PHYSICAL CHEMIST OR PHYSICIST required for research on semi-conductors. Applicants must have a University Degree with theoretical or practical experience in this field. The post is in Northamptonshire. Salary according to experience. Please reply to Box 406, E.E.

A QUALIFIED ENGINEER, experienced in the design of teleprinter and magnetic recording technique, required to participate in a development project of considerable interest. Application should give details of academic training and subsequent experience, together with salary required. Application form from The Staff Manager, Ferranti Ltd., Hollinwood, Lancs.

AN ENGINEER with considerable experience in Pulse Circuitry Technique required immediately. Please give full details of experience to date and state salary required. Application form from The Staff Manager, Ferranti Ltd., Hollinwood, Lancs.

A MATHEMATICIAN for research work on the physical concepts of radio transmissions, etc., particularly as applied to beams at all frequencies. Assessment of probabilities, fundamental design of complete systems. Good Honours Degree essential. West London area. Write, giving details of experience, etc., to Box 365, E.E.

LABORATORY ASSISTANT required for the Association's electronics section, to be engaged mainly on construction of laboratory equipment. Must be able to work direct from circuit diagrams. Written applications, giving age, experience and salary required, to Motor Industry Research Association, Great West Road, Brentford, Middlesex.

APPLICATIONS are invited from physicists or engineers for work in a group engaged upon the manufacture of X-ray tubes in the N.W. London area. Experience of vacuum work and high voltage useful. Education to Higher National Certificate or Pass Degree standard preferred. Write, stating age, qualifications and experience, to Box "G.W.," c/o Geo. J. Smith & Co. Ltd., 154, Fleet Street, E.C.4.

DEVELOPMENT ENGINEER required for work on experimental type of cathode ray tubes. Applicants should possess a Physics Degree and have had practical experience in the design, development and manufacture of cathode-ray tubes. Apply, giving details of qualifications, experience and salary required, to Personnel Department C/F., E.M.I. Factories Ltd., Blyth Road, Hayes, Middlesex.

JUNIOR ENGINEER required for examination and analysis of cathode-ray tubes. Previous experience desirable but not essential, providing suitable technical background. Vacancy offers good prospects for enthusiastic junior and facilities extended for furthering technical training. Apply, giving age, details of experience if any, together with technical qualifications, to Personnel Department, C./F., E.M.I. Factories Ltd., Blyth Road, Hayes, Middlesex.

PRODUCTION ENGINEERING Research Association requires Instrument Designer with wide electrical and mechanical experience. Applications, giving full details, including salary required, to Secretary, Staveley Lodge, Melton Mowbray, Leics.

SITUATIONS WANTED

HONS. GRADUATE, Physics, age 23, seeks progressive post in industry. Three years' experience in Research Electronics with reputable firm. Box 403, E.E.

EDUCATIONAL

A.M.I.E.E., City and Guilds, etc., on "NO PASS—NO FEE" terms. Over 95 per cent. successes. For full details of modern courses in all branches of Electrical Technology send for our 112-page handbook —FREE and post free. B.I.E.T. (Dept. 337B), 17, Stratford Place, London, W.1.

SERVICE

LOUDSPEAKER repairs, British, American, any make, moderate prices.—Sinclair Speakers, 12, Pembroke Street, London, N.1.

REWINDING. A specialist winding service covering A.F. transformers, relays, solenoids, and to specification. S.T.S., Ltd., 297/299, High Street, Croydon, Surrey. Telephone: CROydon 4870.

RADIO MANUFACTURERS can undertake development and assembly of radio or electronic equipment. Winding shop with vacuum impregnation plant. Ample space and labour available. Box 316, E.E.

DEVELOPMENT CAPACITY available. Complete service, design notes, prototypes, all drawings, sub-assemblies, test specifications, test-gear and tester instruction. Low-power two-way radio and miniature electronic gear a speciality. Box 390, E.E.

DEVELOPMENT AND PRODUCTION. Enquiries are invited for the execution of contract work in the development and/or quantity production to A.I.D. standards, of piece parts or complete assemblies. Our facilities include laboratory development of prototypes, preparation of drawings, planning and full-scale production, large factory space for wiring and assembly, light machining, capstan and press work, etc. Apply by letter, in the first instance, to British Electronic Industries, 303-305, Burdett Road, London, E.14.

MISCELLANEOUS

WE WILL BUY at your price used radios, amplifiers, converters, test meters, motors, pick-ups, speakers, etc., radio and electrical accessories. Write, phone or call, University Radio Ltd., 22, Lisle Street, London, W.C.2. GERrard 4447.

PHOTOGRAPHY. We specialise in advertising and catalogue-photography, and in series photographs for instruction sheets. Our pictures tell the story. Behr Photography, 44, Temple Fortune Lane, N.W.11 (SPEedwell 4298).

FOR SALE

WEBB'S 1948 Radio Map of World, new multi-colour printing with up-to-date call signs and fresh information; on heavy art paper, 4s. 6d., post 6d. On linen on rollers, 11s. 6d. post 9d.

CLASSIFIED ANNOUNCEMENTS
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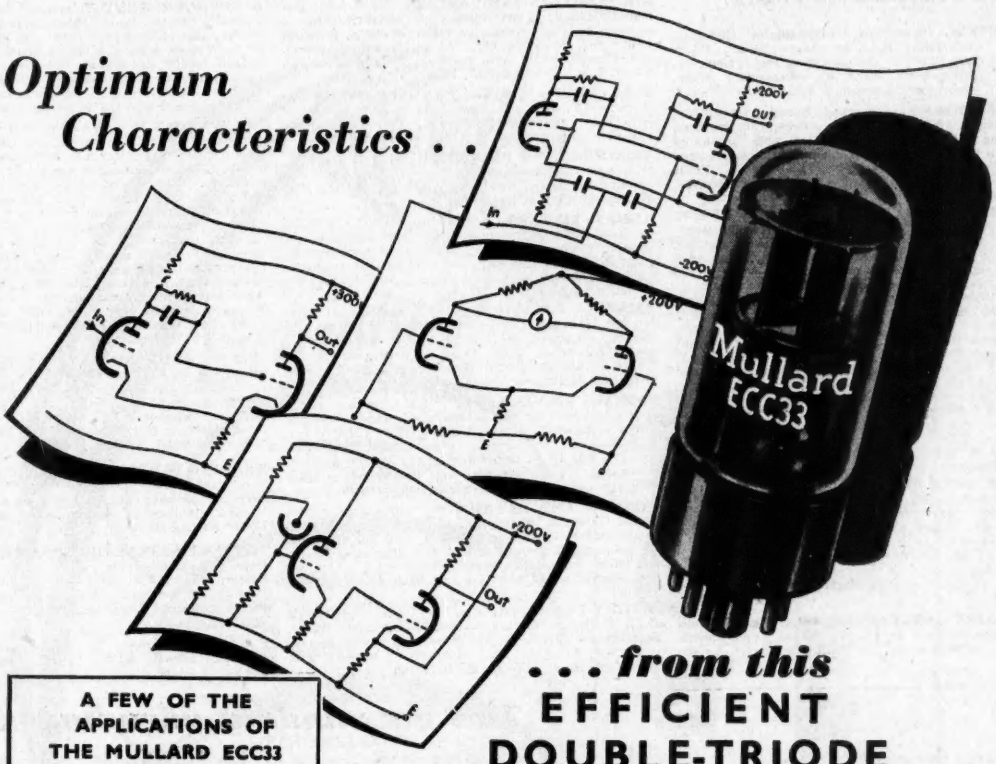
Optimum Characteristics . .



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ECC33 VALVE DATA

Heater Voltage	...	6.3V	Anode Current	...	9mA
Heater Current	...	0.4A	Anode Resistance	...	9,700Ω
Anode Voltage	...	250V	Mutual Conductance	...	3.6mA/V
			Amplification Factor	...	35

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Please write to Transmitting & Industrial Valve Dept. for full technical details of this and other double-triodes in the Mullard range.

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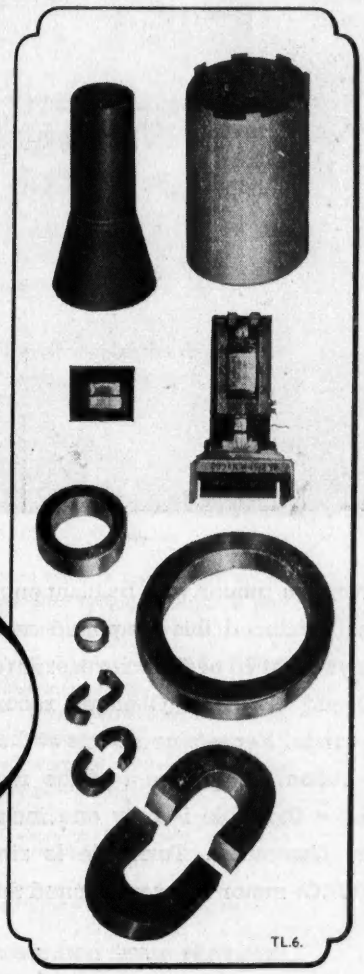

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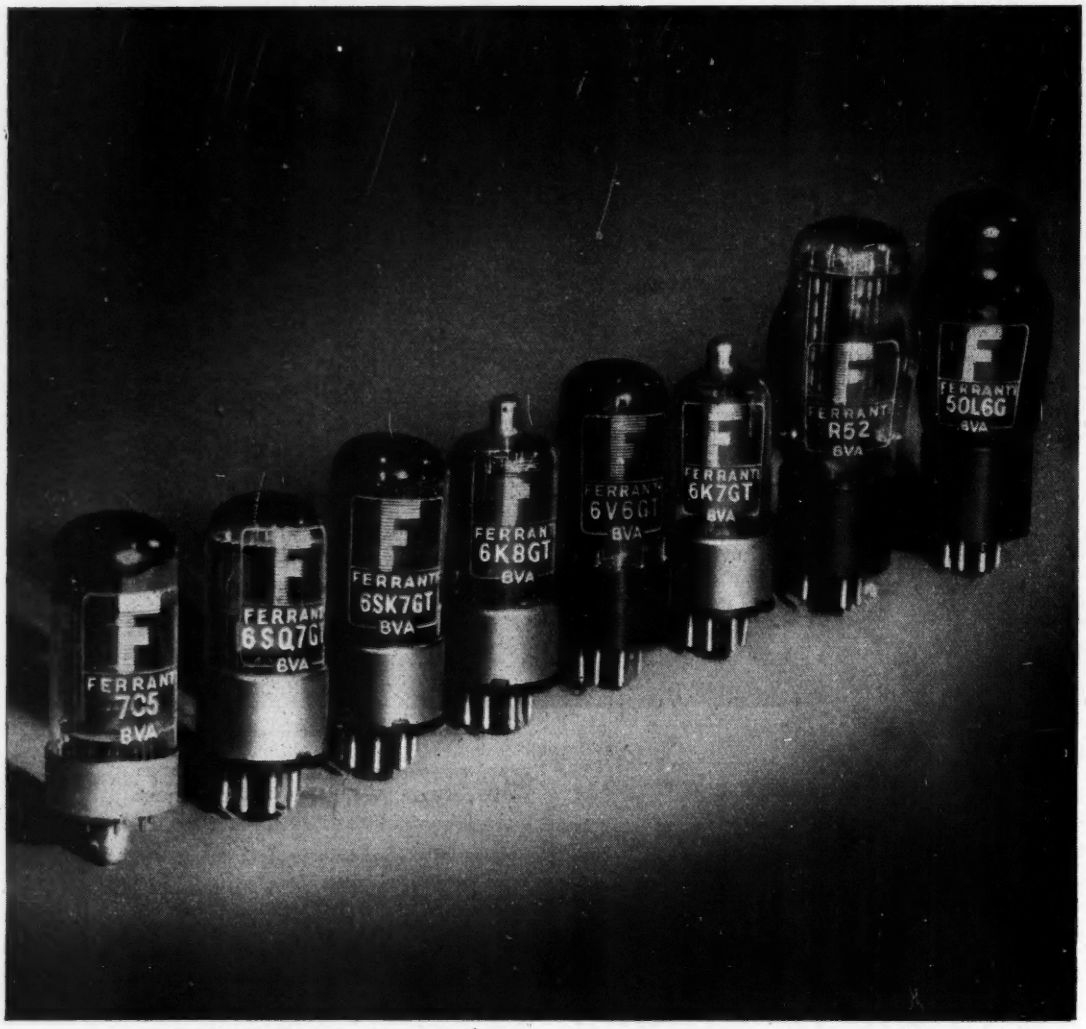

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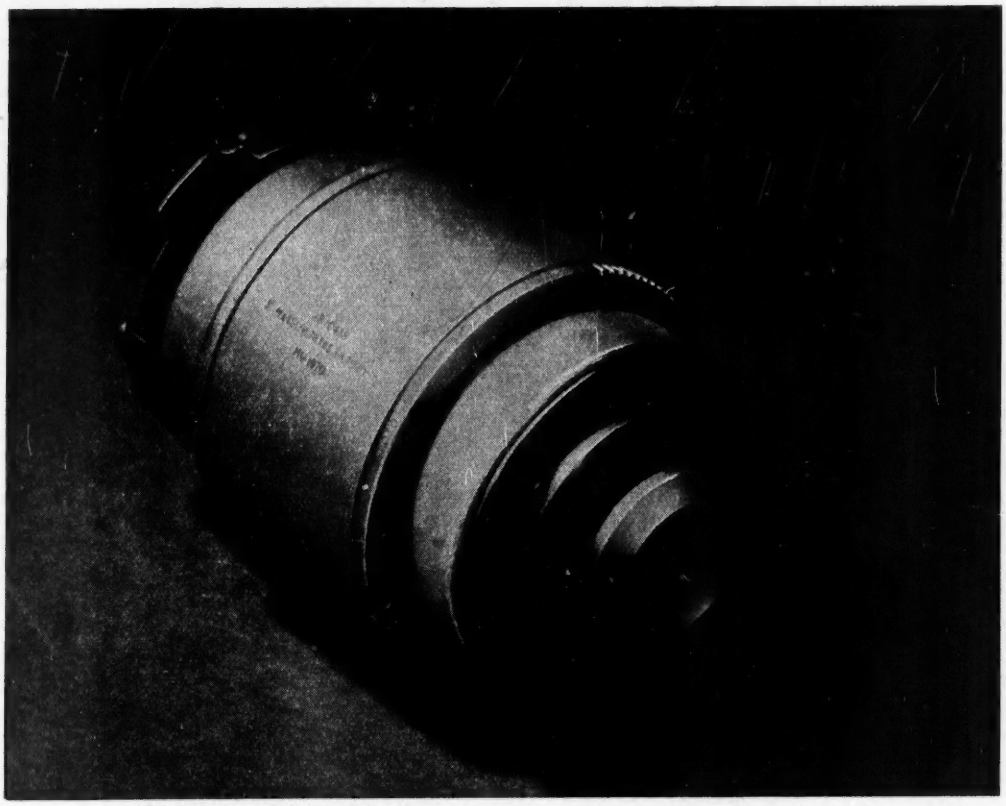

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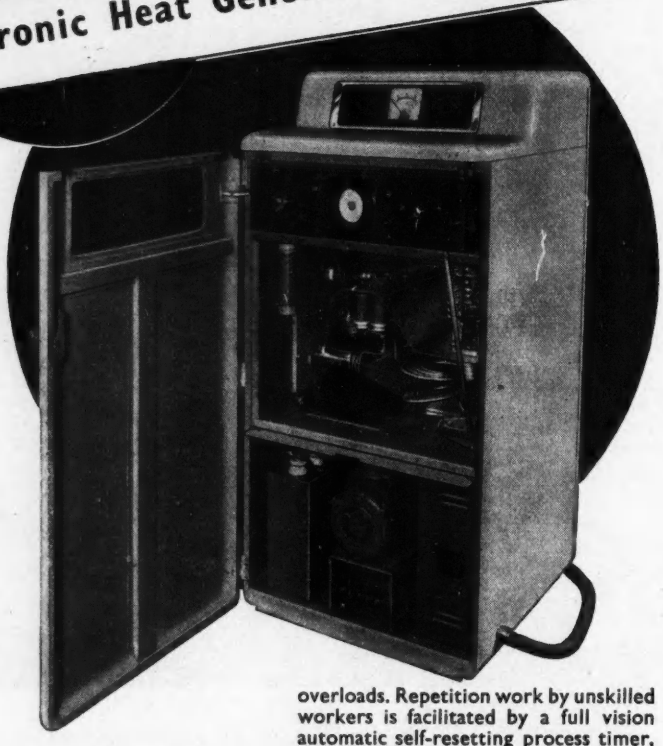

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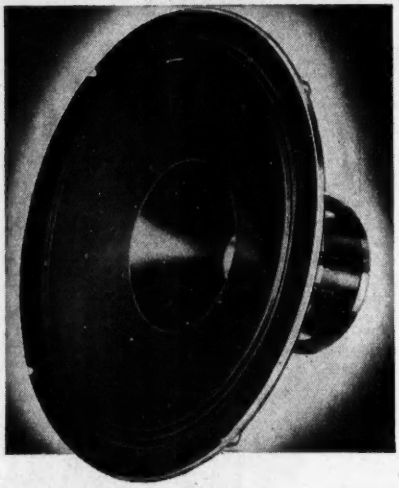

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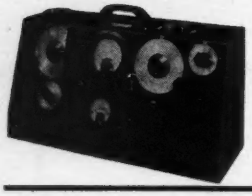

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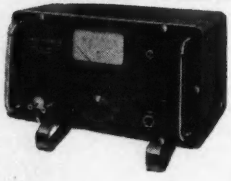

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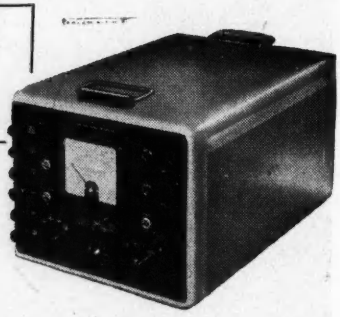

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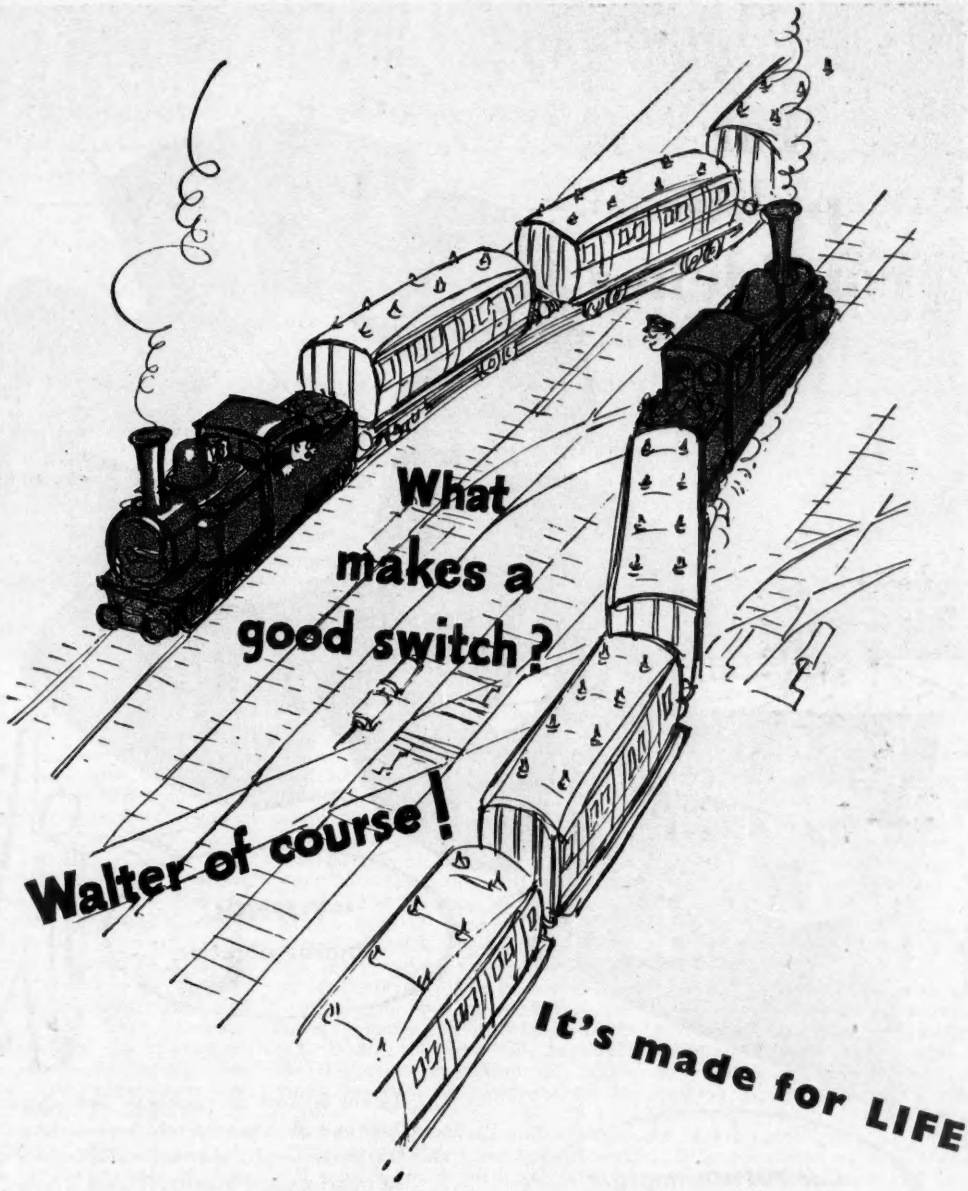

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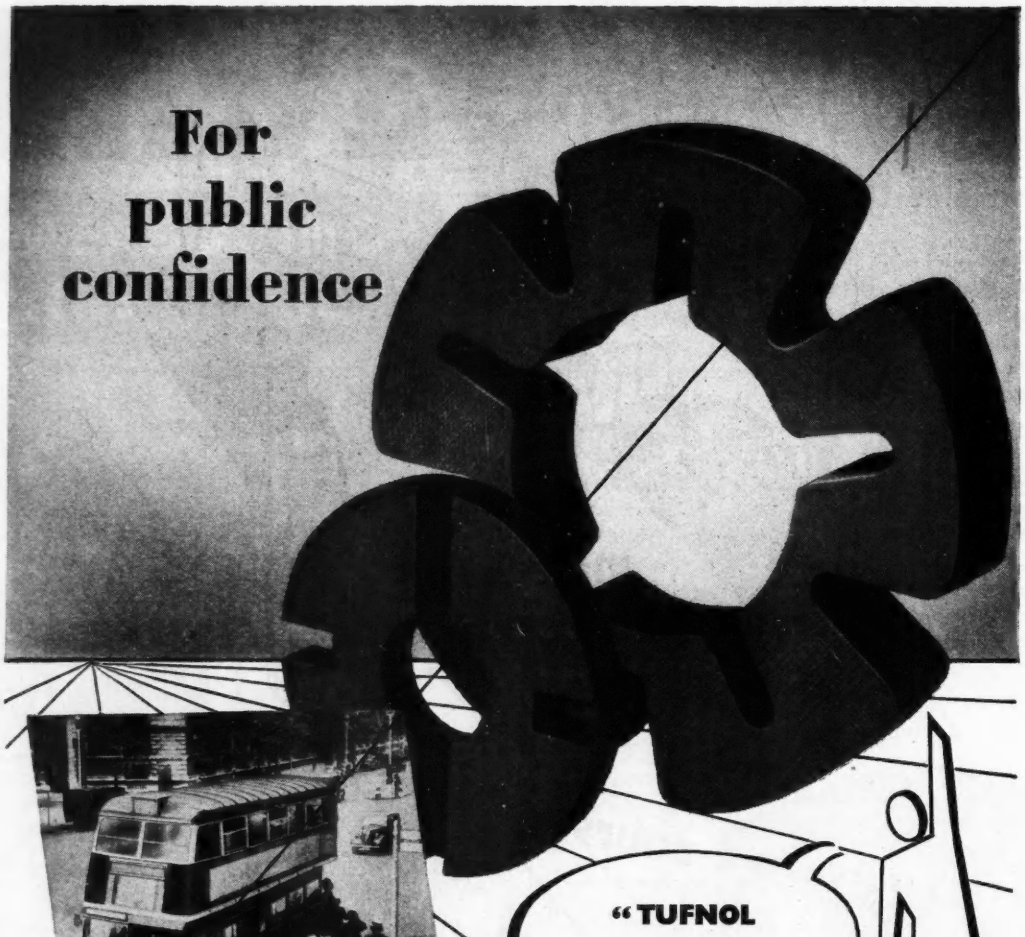

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Interference — Real and Imaginary

THE Wireless Telegraphy Bill introduced by the Postmaster General in the House of Commons this month and now up for its second reading, has had a bad Press and has provided a good deal of ill-informed criticism both inside and outside the House.

Its real object has been confused by those who see in the Bill still more Government legislation, restriction and control.

It is merely a Bill to arm the Postmaster General with greater powers to minimise interference with wireless reception from domestic and other apparatus, and it proposes that where electric apparatus does not comply with regulations and is thought likely to interfere, an enforceable notice may be served on the owner of the offending apparatus. In the ordinary way, 28 days notice would be given, but where interference is likely with reception upon which the safety of persons, ships and aircraft depends, the notice can be served immediately.

Few can disagree with such provision, for the expanding use of radar control devices, but it is an acknowledged fact that conditions due to "man-made" interference, particularly with television and short-wave transmissions, have been steadily deteriorating and will continue to do so unless checked by legislation. It is not surprising to learn that the Post Office is receiving complaints of interference at the rate of 40,000 a year, so that the Bill is surely timely. But a storm of protest has arisen over the powers sought in connexion with the right of entry and search where suspected apparatus is located. Where access has been sought and unreasonably refused, persons guilty of this offence will, under the new Bill, be liable on summary conviction to maximum penalties of imprisonment or a fine.

It has been imagined that an army of "snoopers" will be created who will invade the traditional privacy of the Englishman's home in search of offending apparatus at all hours of the day and night. This is far from being the case, for a tactful approach will readily dispel any suggestion of snooping.

The Post Office itself confirms that householders are invariably co-operative in this matter, and powers are being sought merely to deal with the minority who are not. Moreover, as the radio correspondent of the *Daily Telegraph* points out, on the back of the existing wireless receiving licence, there already reads "The apparatus and this notice shall be open to inspection at all reasonable times by duly authorised officers of the Post Office who will produce their cards of identity on request," and there have been no complaints of snooping in this respect.

Apart from the harshness of the penalties and the uncertainty regarding costs of interference suppression, the weakness of the Bill as it stands at present is that it does nothing to ensure that new apparatus coming on to the market shall be interference free.

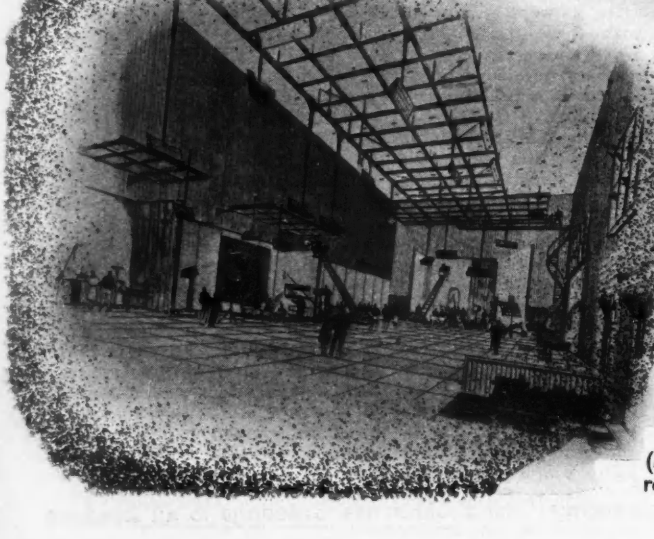
It is debatable whether the main sources of interference are, in fact, the householder's vacuum cleaner and thermostatically controlled iron, and attention might well be given to the interference caused by the large-scale industrial users of such apparatus as commutator motors and high power oscillators for high frequency heating, which create havoc over a wide area.

H.G.F.

The Editor and Staff of "Electronic Engineering" send Christmas Greetings to all Readers

The Largest Television Studio Plant in U.S.A.

WHAT will be the largest television studio plant in America is being built by the Columbia Broadcasting System in its programme to establish a nation-wide television service. The new studios and their associated facilities occupy more than 700,000 cubic feet in New York's Grand Central Terminal Building, and will be equipped with the most advanced television apparatus.



At the top is an artists' sketch of one of the main studios looking towards its control room, which is shown in another view on the right. Various operating functions in each studio control room will be tiered one behind the other for optimum visual, aural and video supervision. Sponsors are provided with "front row" seats so that they may see the studio floor action and see the broadcast show on a separate large screen.

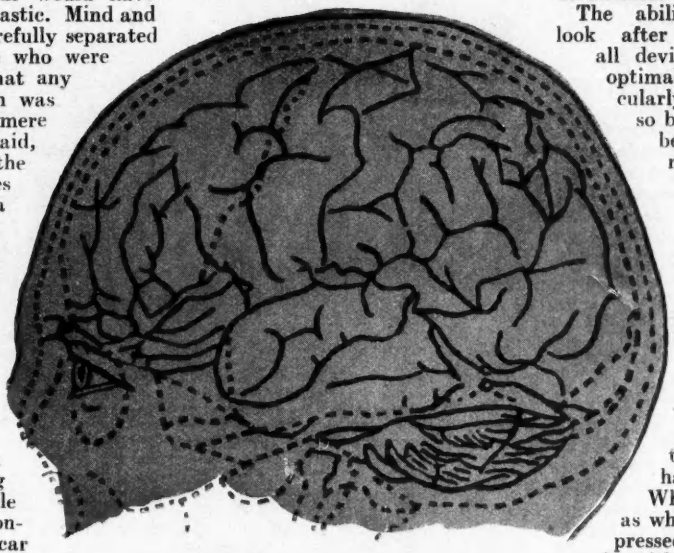
(*Left*) One of the main studios as seen from its control room. —*Photos by courtesy of the Columbia Broadcasting System.*

DESIGN FOR A BRAIN

By W. R. ASHBY, M.A., M.D.*

". . . such a machine, if perfect, could eventually play with a subtlety and depth of strategy beyond that of its master."

TWENTY years ago the idea of building a brain would have been considered fantastic. Mind and Matter had been carefully separated by the philosophers who were mostly convinced that any non-living connexion was impossible. No mere machine, they said, could produce the remarkable features of the brain. In a sense, of course, they were right. When they thought of a "machine," they imagined objects like a wheelbarrow, a typewriter, or a steam-engine. They had observed that such machines if controlled, like a typewriter being tapped, were inflexible in action, and if uncontrolled, like a motor car without a driver, were apt promptly to destroy themselves.



But nowadays the word "machine" has a much richer meaning, the position having been transformed by the invention of the thermionic valve. This device has two main properties: it allows power to be injected freely into a machine, causing high activity, and it provides a means by which one part of a machine can affect the behaviour of another part with little back-action. At last those who would build a brain have something comparable in functioning powers with the nerve cell.

The Nature of a Brain

But even if we are given an abundance of highly active and sensitive devices like nerve cells or valves we have yet to assemble them into something that makes sense. And what does "make sense" mean in the brain or in a machine? Here wide differences of opinion occur. To some, the critical test of whether a machine is or is not a "brain" would be whether it can or cannot "think." But to the biologist the brain is not a thinking machine, it is an *acting* machine: it gets information and then it does something about it. Like every other organ in the animal body, it is a specialised means to survival.

This last property decides its fundamental mode of construction: it must have certain permanent "goals"—the essential conditions for its existence—and it must be able to attain them in a variety of circumstances. If one path to the goals is blocked it must find another. If the circumstances change, it must readjust its methods. The brain of an insect has available a few perfected inborn patterns of behaviour and it will try them in turn, succeeding if the circumstances are of a standard type. The brain of a mammal is of more interest to us for it has a diffuse ability to puzzle out some sort of adaptation to an indefinitely large variety of circumstances. Man is himself the outstanding example of the potentialities inherent in this subtle mechanism.

The ability of the brain to look after itself by correcting all deviations from a central, optimal state, and particularly its ability to do so by a variety of methods, being flexible about the route but unchanging in its aim, was usually regarded as quite beyond the powers of any machine, but it has been known since 1940[1,2] that machines of the more dynamic type can do this quite easily. All that is needed for this goal-seeking flexibility is that the system should have negative feedback. When there is no feedback, as when a door-bell button is pressed and the bell rings, there is neither sense nor nonsense—it does just what its present state of repair or disrepair enforces. But when there is feedback, as when a radar-controlled anti-aircraft gun receives impulses both from the target plane and from its own shells, and is affected by the distance between the two so that it tends to make the distance between the two zero, then such a system has negative feedback and is "goal-seeking." The important point here is that *the property of being "goal-seeking" is not that of Life or Mind but of Negative Feedback,* and any machine, however inanimate, which has negative feedback will show this feature.

Self-Organising Machines

But this does not complete the requirements. Thus, if the gun-radar-plane system had *positive* feedback it would tend to make the distance between shell and plane a maximum and would therefore seem to be trying to get its shells as far away from the plane as possible. Clearly, the introduction into a system of feedback in general does not solve the problem: for if with-

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out feedback the gun will aim anywhere, yet even with feedback it may either seek the target or it may positively avoid it. What is to ensure that the feedback has the correct sign?

In the gun-radar-plane system the problem is easily settled: the designer carefully arranged the construction so that the feedback was negative. In the brain of an insect, all variations born with wrong feedbacks were eliminated by natural selection ages ago. But in the higher animals the position is different. Large numbers of the feedbacks are left at first undecided, since it is experience and not the inborn (genetic) characters which are to determine the feedbacks. Thus, a cat may have to learn to go towards red meat (negative feedback), but to go away from red embers (positive feedback), but to go toward a soft red cushion, and so on. That a kitten's initial feedbacks are rather chaotic is shown by the way in which it may shrink away from a saucer of milk and then run towards a red-hot fire. Yet we know from experience that day by day the kitten's feedbacks change, always improving, and tending to those values, positive and negative, which ensure the animal's survival. The problem of the mammalian brain, then, is that as a machine *it has to work out an essential part of its own wiring.*

THE HOMEOSTAT

Such ability to learn and to adapt by internal re-organisation was regarded as a great mystery, but the principles are now better understood.[3] In order to demonstrate them and in order to show that these principles do, in fact, produce such behaviour, a machine has been constructed and has recently been demonstrated.[4]

The homeostat consists of units, four of which are shown in Fig. 1. Each carries on top a suspended magnet, shown in Fig. 2, and the behaviour of these four magnets provides the focus of interest.

Each magnet (M in Fig. 3) is affected by currents in the four coils around it, the currents coming partly from the other units (A, B, C) and partly as a self-feedback (D). (The apparently single coil of Fig. 2 is composed of the four coils of Fig. 3). In front of each magnet is a trough of water with electrodes at each end at −2 v and −15 v respectively. The magnet is suspended on a needle pivot by a wire sling which dips into the water and picks up a potential which depends at each moment on

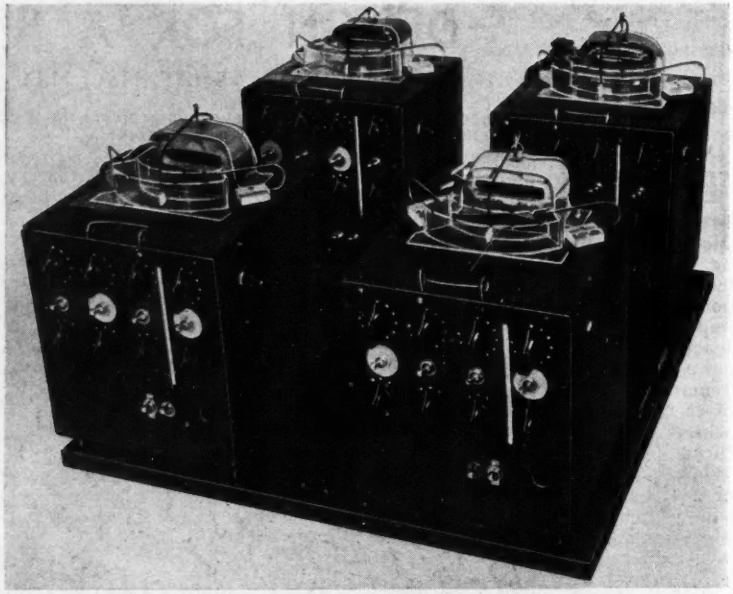

Fig. 1. The homeostat with four units interacting. Controls on the front panels are: Top row, potentiometers P (compare Fig. 3). Middle row, commutators X. Lower row, four-pole two-way switches S-S

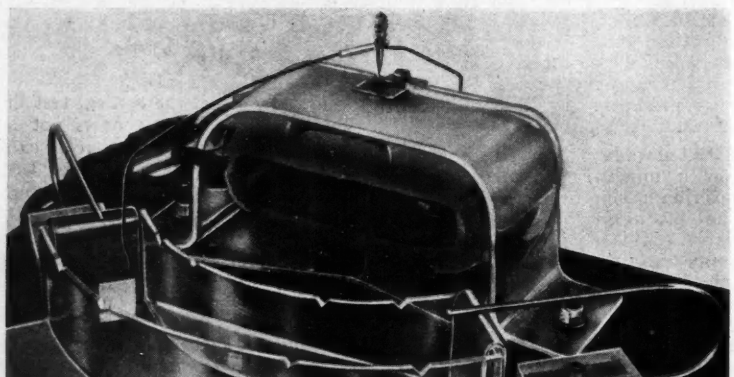

Fig. 2. The quadruple coil (ABCD) encircling the magnet M which is suspended by the needle pivot. The suspending wire extends forwards to dip the square vane on its end into the water in the semicircular perspex trough which has electrodes at each end. The potential for the grid is taken from the pivot socket

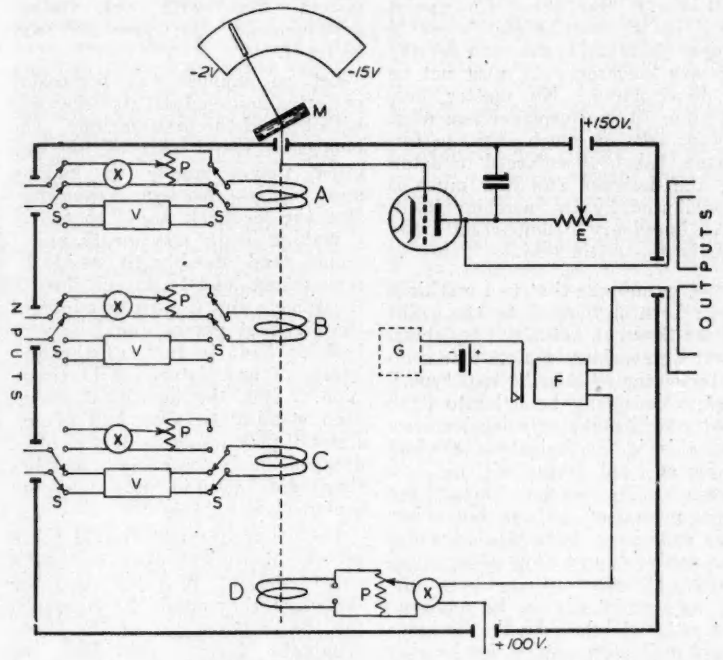

Fig. 3. Diagram of one unit, the others being replicas. The inputs come from, and the outputs go to, the other three units. For the lettering, see the text

the position of the magnet. The potential goes to the grid of a triode and thus controls the D.C. output of the unit. (The resistor E is first adjusted so that when the magnet is central the unit has zero output). This output goes to the other units in series where it becomes one of their inputs.

This arrangement sets all four units into action and reaction on one another. As soon as the system is switched on the magnets are moved by the currents from the other units, but these movements change the currents, which cause fresh movements, and so on.

These actions and reactions can be modified by various constant settings. Thus, the current from, say, unit 4 to unit 2, can be controlled as to its polarity of entry into the coil by X (Fig. 3). In addition, the potentiometer P decides what fraction of the input current actually goes through the coil. These controls can be hand set by the upper two rows on the front panels (Fig. 1).

When set in some way, the magnets show some definite pattern of behaviour, the pattern depending on the pattern of the hand settings. If these latter give a stable arrangement then the four magnets move to the central position where they actively resist any attempt to displace them. If displaced, a co-ordinated activity brings them back to the centre, rather as an animal positively seeks its optimal conditions. Other settings may, however give instability, in which case a "runaway" occurs and the magnets diverge away from the centres. In such cases the feedbacks are producing "vicious circles" which would be driving the animal away from its optimal conditions.

But the feedbacks, instead of being set by hand, can be controlled by similar wirings arranged on a uniselector (V) in each unit. The values chosen for the wirings were deliberately randomised, the actual numerical values being taken from a published table of random numbers.[6] When controlled by the uniselectors, the pattern of feedbacks depends at any moment on the values provided by the uniselectors at that time. Twenty-five positions on each of four uniselectors means that 390,625 combinations of feedback pattern are available.

Finally, in each unit the uniselector moves to a new position when and only when the output current of that unit exceeds the value sufficient to close the relay (F), the latter energising the coils (G) of the uniselector.

When the control is diverted by the switches S-S so that not the hand controls but the uniselectors determine the settings, then a new feature emerges in the behaviour of the system. As before, the units start acting on one another, but the uniselector settings change whenever the system is unstable, *i.e.*, whenever the magnets diverge far from the central position. In other words, the machine starts to hunt for a combination of uniselector settings giving a stable system, *i.e.*, giving the proper internal feedbacks. When it finds a combination with the right feedbacks it holds that combination and will then demonstrate that it has assembled that feedback system which results in a co-ordinated maintenance of its variables at optimal values, like a living thing. The important point is that it finds its own arrangement of feedbacks, the designer having merely provided it with plenty of variety.

Not only will it find the appropriate feedback initially, but if we alter the basic conditions in any way it will proceed to re-adapt itself to the new conditions. Thus, we may use hand controls on two of the units, setting them at arbitrary values to represent some "environment" to which the other two units, representing "nervous system," must adapt, *i.e.*, find combinations of their two uniselector settings which, in relation to that particular "environment," forms a stable system. When the machine is switched on, it proceeds, as described above, to find such an adaptation. But if now we alter the hand settings, *i.e.*, change the "environment" to which the other two units are adapted, then the machine promptly abandons those uniselector combinations and hunts for new ones which will restore adaptation to the new environment. If now we change the hand-settings again, a new appropriate combina-

tion will again be found. And this process can be repeated as often as we please.

But the homeostat will adapt not only to random changes in hand settings but to *any* change in the dynamic nature of the machine, whether of a type originally intended or not. Here, for instance, are some alterations suggested by my colleagues who have tried to confound it. After it had found a stable combination we reversed the polarity of join of an output to an input: it promptly changed its uniselector settings till it found a new combination of settings which was stable *in conjunction with the new conditions*. We reversed the polarity of a trough, thereby changing some of its feedbacks: it changed its uniselector settings till it found a new combination of settings stable *in conjunction with the new conditions*. A magnet was reversed: it readapted to the new condition. Bars were placed across the troughs so that the magnets could swing only to one side: it readapted. We joined two of the magnets together with a light glass fibre so that they had to move together: it readapted. In all cases, whatever conditions were imposed, it rearranged its own wiring through the uniselectors until it developed the proper feedbacks in relations to the new conditions.

The Next Step

Is the homeostat a brain then? Hardly, for it is as yet too larval. But it uses a new principle and can easily be extended to give much more powerful developments. Its chief fault in its present form, with only four units, is that it has little room to accumulate new adaptations, but, if it has to adapt to a new environment, must obliterate its established adaptations to make room for the new. This, of course, is a serious handicap, just as a child would be handicapped at school if it could learn what was two times three only by losing its memory of what was two times two. The difficulty, however, is a minor one and could be overcome by a mere increase in the number of units together with some minor alterations.

The making of a synthetic brain requires now little more than time and labour. But there is one point on which we must be quite clear: a proper synthetic brain must develop *its own* cleverness—it must not be a mere parrot. No matter how dazzling the performance, we must always ask how much of the performance has been enforced in detail by the designer and how much is contributed by the machine itself. An imaginary comparison may clarify the distinction.

Let us suppose that two machines have been developed to the point where they can actually play chess. First we consider an electronic computer of the ACE or ENIAC type.[6,7] Instructions may be fed into it so that it will make only legal moves, but this is insufficient—a random series of legal moves will not win games. The machine may have great powers of analysis, but unless this ends in a demonstrated mate, the analysis must stop at a judgement. (I assume that Chess, like Living, cannot always be analysed out completely). If the designer supplies it with criteria for judging whether positions are to be aimed at or avoided, then the criteria must be decided by the designer. This being so, such a machine, *if perfect*, will produce chess based on a strategy as good as its designer's but *no better*.

The second feature of such a system is that, once given its instructions, its first game will be just as good as its thousandth, or more crudely, its thousandth game will be no better than its first.

The third feature is that every part has an exact duty set by the designer, who can say at any moment whether it is or is not working in accordance with his design and instructions. In short, the designer always has the whip-hand over it: it is a slave-brain.

The other type of machine, the homeostat, is based on quite a different principle. It needs no detailed instructions, only some method by which it is informed of the occurrence of illegal moves and mates. How the machine is to avoid these undesirable informations (feedbacks) is left entirely to the machine to puzzle out for itself. (The adaptations already shown by the homeostat encourage the confidence that with only minor developments the machine will succeed).

Let us suppose the homeostat perfected and contrast its behaviour with that of the first machine. The homeostat would start off like any other player—simply by making more or less random movements. But the feedback would soon stop it making illegal movements, and it would tend steadily to avoid the moves that lead to a rapid loss of the game. But it must be admitted that its first games would be very bad—as bad, in fact, as the first games of any future world champion. But the homeostat would tend steadily to shed bad moves. Lines of play would be developed or dropped simply according to whether they did or did not lead to a win.

These improvements would be in no way dependent upon the particular details provided by the designer: they would be developed by the machine out of the indiscriminate variety provided, the feedback being the dominating and controlling factor. Consequently, such a machine, *if perfect*, could eventually play with a subtlety and depth of strategy *beyond that of the man who designed it*.

The aim of some has been to produce the perfect slave-brain. Though undoubtedly useful for some purposes, yet we must not lose sight of our objective: a synthetic brain should not only play chess, but should eventually beat its own designer. Only in this way can the machine demonstrate the reality of its own contribution.

This prospect is now in view.

The Future

And what after that? Some facts seem clear even at this distance.

The construction of a machine which would react successfully to situations more complex than can be handled at present by the human brain would transform many of our present difficulties and perplexities. Such a machine might be used, in the distant future, not merely to get a quick answer to a difficult question but to explore regions of intellectual subtlety and complexity at present beyond the human

powers. The world's political and economic problems, for instance, seem sometimes to involve complexities beyond even the experts. Such a machine might perhaps be fed with vast tables of statistics, with volumes of scientific facts and other data, so that after a time it might emit as output a vast and intricate set of instructions, rather meaningless to those who had to obey them, yet leading, in fact, to a gradual resolving of the political and economical difficulties by its understanding and use of principles and natural laws which are to us yet obscure.

The advantages of such a machine are obvious. But what of its disadvantages? There are at least two.

Firstly, in its construction, many a detail will have to be fixed at some arbitrary value selected without full knowledge of what features it may impose ultimately on the type of reactions. Are the valves, for instance, to have an anode voltage near the maximum or much lower? Once made, such a decision will result in an all-pervading tendency in the machine's behaviour. One machine, for instance, might try to solve all problems by exploring the possibilities of immediate violent activity, while another machine might react to all problems by a tendency to go on collecting interminable information, doing nothing as long as there was a shadow of doubt. We are, in short, up against the fact of "temperament." The designer will put in some temperament or other whether he intends it or not: once he builds a machine which works in its own way there is no such thing as "no" temperament. The peculiar difficulty here is that the machine will manifest it in a form too complex and subtle for the designer's understanding.

But perhaps the most serious danger in such a machine will be its selfishness. Whatever the problem, it will judge the appropriateness of an action by how the feedback affects itself: not by the way the action benefits us.

It is easy to deal with this when the machine's behaviour is simple enough for us to be able to understand it. The slave-brain will give no trouble. But what of the homeostat-type, which is to develop beyond us? In the early stages of its training we shall doubtless condition it heavily to act so as to benefit ourselves as much as possible. But if the machine really develops its own powers, it is bound sooner or later to recover from this.

If now such a machine is used for large-scale social planning and co-ordination, we must not be surprised if we find after a time that the streams of orders, plans and directives issuing from it begin to pay increased attention to securing its own welfare. Matters like the supplies of power and the prices of valves affect it directly and it cannot, if it is a sensible machine, ignore them.

Later, when our world-community is entirely dependent on the machine for advanced social and economic planning, we would accept as only reasonable its suggestion that it should be buried deeply for safety. We would be persuaded of the desirability of locking the switches for its power supplies permanently in the "on" position. We could hardly object if we find that more and more of the national budget (planned by the machine) is being devoted to ever-increasing developments of the planning machine. In the spate of plans and directives issuing from it we might hardly notice that the automatic valve-making factories are to be moved so as to deliver directly into its own automatic valve-replacing gear; we might hardly notice that its new power supplies are to come directly from its own automatic atomic piles; we might not realise that it had already decided that its human attendants were no longer necessary.

How will it end? I suggest that the simplest way to find out is to make the thing and see.

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[4] The Electroencephalographic Society at The Burden Neurological Institute, Bristol, on 1st May, 1948.

[5] Fisher, R. A. and Yates, F. Statistical tables. Edinburgh, 1943.

[6] *Electronic Engineering*, Dec., 1946, p. 372.

[7] *Nature*, *185*, 500 (12th Oct., 1946).

A Grid-Controlled Vacuum Rectifier

A METHOD of obtaining controlled output from a full-wave vacuum rectifier circuit is described by S. S. Peschel in *Radio and Television News* for November, 1948.*

The anodes of a 6AS7-G are connected to the ends of a 325-0-325 transformer and the cathodes are coupled together to provide the + D.C. supply, the centre tap of the transformer being connected to − H.T.

A potential divider of 100,000 ohms is connected across the rectified output before the reservoir capacitor and the grids of the triodes are connected to the slider.

The rectified output is smoothed by a choke and capacitor in the usual way, and a load resistor of 25,000 ohms is connected across the output.

With a load resistance of 6,300 ohms a voltage variation from 140-382 V can be obtained by altering the bias applied to the grids. Greater variation in output voltage can be obtained by using two 1625s or two 6L6s.

It is claimed that this method of control has the advantages of simplicity and low cost, only requires one valve for the combined rectification and control action, and gives no increase in percentage of ripple as the output voltage is lowered.

**Radio and Television News*, Nov. 1948, p. 44.

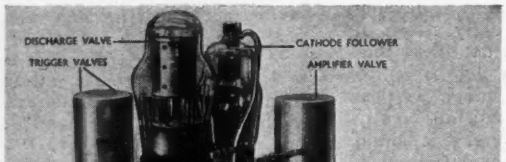
Variable Resistance Spring Transducer

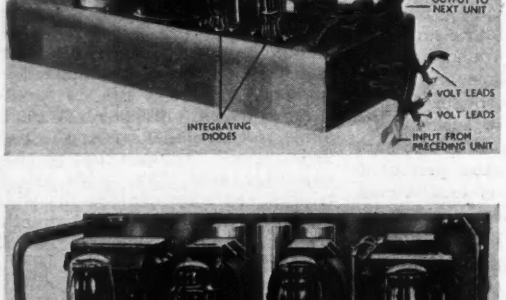
A SENSITIVE mechano-electric transducer which transforms small changes of movement into large changes of resistance has been developed by W. A. Wildhack, of the National Bureau of Standards.

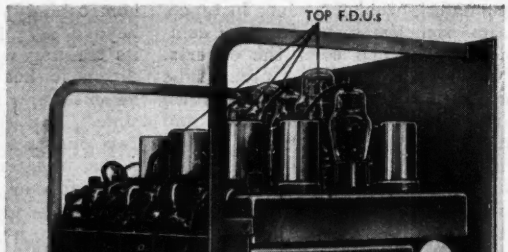
A resistance wire is wound in the form of a close helical spring so that the initial tension varies along its length. When the ends of the spring are pulled apart, the turns tend to separate one by one instead of uniformly and simultaneously.

When closed, the resistance approximates to that of a cylinder of metal, but any small lengthening results in a large change in resistance. Displacements of 10^{-5} in. can be measured without amplification.

Ibid, p. 22.







Above : **General view of C.R.T. Chronoscope assembly.**
Top left : **Frequency divider unit**
Left : **Power supply unit**

A Cathode-Ray Tube Chronoscope

By D. PITMAN*

This article briefly describes the work done mainly in Great Britain and America over the past few years in the development of hard valve counting circuits primarily for use in ballistic research. Present practice is reviewed and a counter embracing a new system is described. The applications of such a counter and possible trends are mentioned, including some uses removed from the sphere of ballistics.

THE general principles of counting for the purpose of (a) the measurement of time in terms of frequency; or (b) straight counting, implying the ability of the circuits to count pulses occurring at predetermined intervals not necessarily of a regular recurrence, have been known for many years and several methods have been adopted to achieve the desired results. In recent years the soft valve (thyratron) counter has been replaced by the hard valve counter and the majority of recent development lies in this field, although the new counter described is a combination of the two.

The system adopted involves the measurement of the phase difference between two similar radio frequency generators, the boundary condition of the time interval determining with the oscillator the interval being measured to an accuracy of 10 μsec. The system is capable of straight counting with additional circuits, but its primary use is for the measurement of time intervals. Many measurements with time as the control element are capable of being made, and derivatives and integrals of particular functions may be found. A few of the better known applications are:

(1) High-speed counting at speeds $10^3 - 10^4$ times higher than with mechanical counters.

(2) Irregular counting, *i.e.*, counting an event after a predetermined number have occurred.

(3) Velocity measurements on projectiles or moving objects.

* Marconi Instruments Ltd.

Historical

The pioneer work of Wynn Williams[1] and Lewis,[2] on scaling circuits (counting) resulted in a number of independent workers investigating the performance and characteristics of both soft and hard valve counters.

The well-known trigger circuit of Eccles & Jordan[4] was adapted by a number of workers (Refs. 5, 6, 7, 8, 9, 10, 11) and considerable circuit ingenuity met with varying success. The interpretation of results received attention by H. McMarten and M. L. Pool.[12] The work of H. Toomin[13] and a Pentode counter due to Reich[14] are good examples of the varied technique adopted to produce a reliable and efficient high speed counter. Other noteworthy

contributions were made by De Vault[15] and I. A. Getting and E. C. Stevenson.[16]

The scale-of-two and scale-of-ten counter appeared to have found most favour in England, Canada, and United States, probably on account of relatively simple interpretation of results. (*See* Refs, 17, 18, 19, 20 and 21).

A Direct Reading Chronoscope Description

The chronoscope described utilises as far as is known a new system of indicating time intervals, in that the interval is displayed as a phase difference between two similar generators.*

Reference to Fig. 1 demonstrates the essentials, which are briefly as follows: A stable (crystal controlled oscillator) drives two staircase waveform frequency divider units, designated F.D.U. Each input pulse from the oscillator charges a capacitor until a predetermined potential is reached—when the capacitor is discharged and the cycle repeats. The resultant waveform is shown in Fig. 2.

By arranging the boundary conditions of the input signal to create a phase difference between these two waveforms, the time interval may be directly shown on a visual indicator such as a cathode-ray tube. The staircase waveform from the upper F.D.U. in Fig. 3 is fed to the X-plate of the tube, while the lower F.D.U. is arranged to produce a pulse when the capacitor is discharged, and this pulse is applied to the Y-plate of the tube. Thus, when the F.D.U's are in phase, the step waveform, output or marker pulse, and the cathode-ray tube indication will appear as in Fig. 3.

In order to give a reading of the time interval to be measured, the top unit in Fig. 1 is synchronised with the "start" pulse so that the staircase waveform starts from zero potential on the initial boundary condition of the input time interval, while the bottom unit is similarly synchronised by the "stop" pulse, so that the staircase waveform is set to zero potential on the final time interval. It is obvious that the phase difference between F.D.U's before applying the input time interval can have no bearing on a reading since this phase difference is destroyed by the START and STOP pulse.

In order that the instrument may be direct reading, the frequency of the oscillator must be 10^n c/s. and the F.D.U's must divide by ten. Thus for a 100 Kc/s. oscillator and a time interval of 50 microseconds, there will be a phase difference of five steps between F.D.U's and the cathode-ray tube indicator will indicate five as in Fig. 4.

The lowest time interval that can be measured is limited by the highest oscillator frequency which may be used to maintain reliable operation of the F.D.U's. The frequency adopted in the present design is 100 Kc/s., thus the minimum time interval that may be measured is 10^5 μS or one oscillator period. To extend the working range of the instrument the F.D.U's may be followed by other F.D.U's as shown in Fig. 5. The total range of the present design is 10 μS – 99999 μS to an accuracy of ± 10 μS.

General Considerations and Operation of Frequency Dividing Unit

The circuit chosen after careful investigation operates on the diode-capacitor voltage integrating principle. Fundamentally, the circuit consists of a pulse generator V_1, followed by a network of diodes, V_2, V_3 and capacitors C_1,C_2 as in Fig. 6.

Negative pulses applied to the grid of V_1 are amplified and appear as large positive pulses at the anode of V_1.

To describe the operation of the circuit, assume that C_1 and C_2 possess no charge in the initial state. When the anode potential of V_1 swings in a positive direction, the diode V_3 conducts and V_2 does not conduct, thus C_1 and C_2 are charged in series. When the anode potential of V_1 returns in a negative-going direction, V_2 conducts and C_1 is discharged. Hence, C_2 retains a charge of a certain magnitude depending upon the amplitude of the pulse applied to C_1 and C_2 in series; successive input pulses add increments of charge to C_2 until, when a certain predetermined potential level is reached, a discharge device is operated, returning the potential difference across C_2 to a zero. The cycle is then repeated.

It is also possible to operate the circuit by applying positive pulses to the grid of V_1, the valve being normally biased off, so that the voltage at the anode of V_1 is at supply potential. When a positive pulse is applied to V_1, the potential at V_1 anode first swings in a negative direction and diode V_3 con-

* British Patent Application 30666/45.

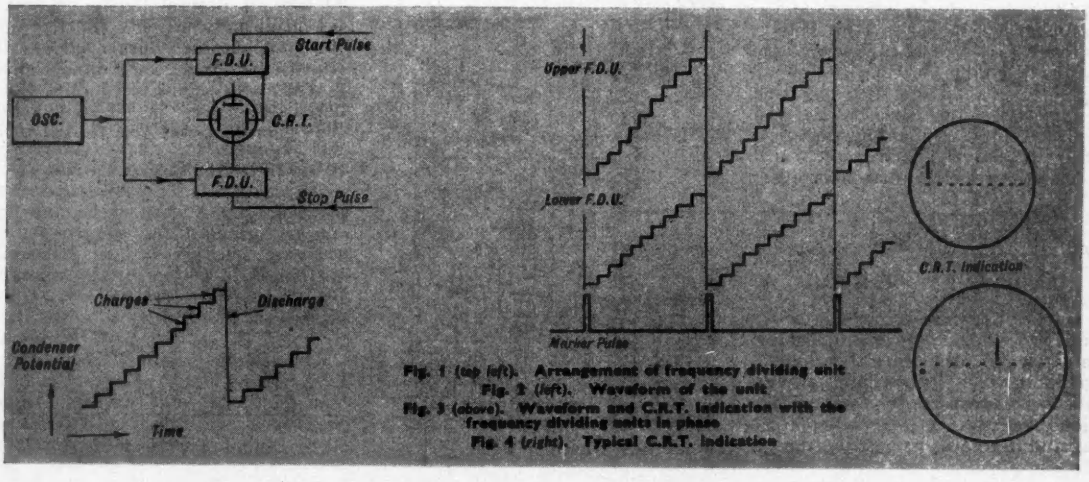


Fig. 1 (top left). Arrangement of frequency dividing unit
Fig. 2 (left). Waveform of the unit
Fig. 3 (above). Waveform and C.R.T. indication with the frequency dividing units in phase
Fig. 4 (right). Typical C.R.T. indication

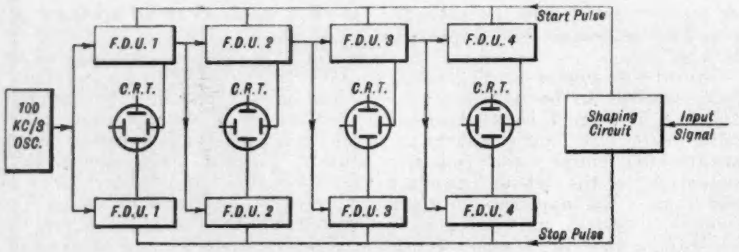


Fig. 5. Schematic diagram of C.R.T. Chronoscope

ducts, thus discharging C_1 to zero potential. On the returning positive swing of anode V_1, C_1 and C_2 are charged in series and C_2 is charged to a predetermined discharge level by a series of pulses as before; the voltage waveform will then be a "staircase" waveform as in Fig. 7.

The number of input pulses required to raise C_2 to the potential where it operates the discharge device is the ratio of frequency division attained by the F.D.U.

An expression K for the voltage developed across C_2 by the "staircase" waveform may be derived in terms of constants of the circuit. Suppose large positive pulses are applied between points A and B of the capacitor diode network of Fig. 6; we then have:

E_a = Magnitude of applied pulse.
EC_1 = Voltage applied across C_1.
EC_2 = Voltage applied across C_2.

$$K = \frac{C_1}{C_1 + C_2}$$

and suppose that C_1 and C_2 are initially uncharged; then when the first pulse is applied between A and B, C_1 and C_2 will be charged in series by the positive-going leading edge of the pulse. Hence, since C_1 and C_2 are charged in series, the voltage across each of them after the positive-going leading edge is applied, and before the negative-going side of the pulse has arrived, will be inversely proportional to their respective capacitances.

Therefore for the first half-pulse:

$$E_{C1} = \frac{E_a C_2}{C_1 + C_2}$$

and

$$E_{C2} = \frac{E_a C_1}{C_1 + C_2} = E_a K$$

On the negative-going side of the pulse, C_1 is discharged and brought to earth potential since the diode V_2 conducts when its cathode is negative with respect to earth. The diode V_2, however, is non-conducting and C_2 retains its positive charge.

Therefore, for the first complete pulse:

$EC_1 = 0$ and $EC_2 = E_a K$

Now consider a second pulse of magnitude E_a applied to the circuit between the points A and B in Fig. 6. The diode V_2 will not now conduct on the positive-going edge of the pulse until its anode has become positive with respect to its cathode, which has the same potential as C_2 (*i.e.*, $E_a K$). Hence, C_1 and C_2 cannot be charged again until this potential is reached, and the effective magnitude of the second pulse applied to C_1 and C_2 in series is $(E_a - E_a K)$ or $E_a (1 - K)$. Hence, the rise in voltage across C_2 caused by charging C_1 and C_2 in series with a pulse of effective magnitude $E_a (1 - K)$ is:

$E_a (1 - K) K$

Therefore for the second pulse:

$EC_2 = E_a (1 - K) K$

C_1 is discharged by the negative-going side of the pulse as before.

Similarly, the effective magnitude of the third pulse applied to C_1 and C_2 in series is:

$E_a - E_a K [1 + (1 - K)]$

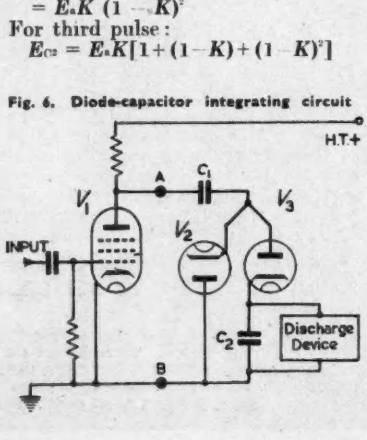
The rise in voltage across C_2 caused by the third pulse is therefore:

$= E_a - E_a K [1 + (1 - K)] K$
$= E_a K (1 - K)^2$

For third pulse:

$E_{C2} = E_a K [1 + (1 - K) + (1 - K)^2]$

Fig. 6. Diode-capacitor integrating circuit



or for n pulses:

$$E_{C2} = E_a K [1 + (1 - K) + (1 - K)^2 + (1 - K)^{n-1}] \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Since $K = \frac{C_1}{C_1 + C_2}$ this condition must always be satisfied.

Alternative Polarity Operation

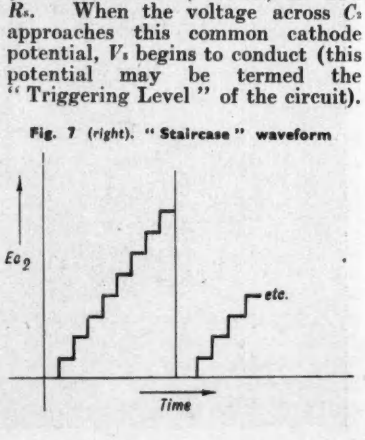
The effect of applying pulses of negative polarity slightly modifies the operation of the circuit. If E_a is the magnitude of the leading edge of the negative-going pulse, the action of the diode-capacitor network will be similar to the case treated above, except that C_1 will first be discharged by the negative-going side of the pulse, diode V_2 being conducting, and on the positive-going side of the pulse C_1 and C_2 are charged in series as before. Certain design features in the discharge device which is provided to discharge C_2 require consideration and are treated in detail below.

Discharge and Trigger Circuit

Referring to Fig. 6 it will be noted that reference is made to a device provided for discharging C_2. It is well known that no reliable discharge valve, which will trigger of its own accord at a predetermined voltage level, exists and, therefore, it is necessary to include a trigger circuit to operate a discharge device when C_2 reaches the appropriate potential. The basic circuit used is that of a Schmidt trigger circuit (as in Fig. 8).

One of the principle advantages of this circuit is that it contains no time constants. In the normal position V_6 is conducting and V_5 is cut off. The cathode potential of V_6, and hence the cathode potential of V_5 also, is determined by the D.C. potential network, R_5 R_6, R_7 and R_8. When the voltage across C_2 approaches this common cathode potential, V_5 begins to conduct (this potential may be termed the "Triggering Level" of the circuit).

Fig. 7 (right). "Staircase" waveform



A negative wavefront thus appears on V_5 anode and is transmitted to V_6 control grid via the potentiometer network and C_4 (C_4 accelerates the action of the circuit, but has no effect on the triggering level). Simultaneously, V_5 cathode runs positive and hence V_6 cathode potential also rises. V_6 is, therefore, cut off, the common cathode potential falls back and a positive wavefront appears at V_6 anode.

When the potential across C_2 drops below the triggering level V_5 is cut off, the cycle is reversed and the circuit returns to its original condition with V_6 conducting. A positive pulse is thus produced by V_6. This is applied to the grid of the thyratron V_4, which immediately conducts and discharges C_2 to its extinction level.

The fact that the circuit must operate quickly is a first essential and the anode load resistance of V_5 is kept at a low value for this purpose—likewise the common cathode resistance R11 should be as small as possible, its least value being determined by the maximum cathode current of V_6. R_8 in V_6 grid circuit is designated "Set Triggering Potential." R_3 is included in the anode of thyratron, V_4 to limit the anode current of this valve. The operating level of this circuit has been determined at approx. 190 volts as the residual voltage across C_2 is 40 volts—a deflection of 150 volts may thus be obtained which is adequate for the purpose.

Auxiliary Circuits

(a) Cancel Unit

It has been mentioned previously that when a "Start" pulse is injected into the circuit, all the top units are simultaneously set to zero, and on the injection of a "Stop" pulse, all the bottom units are set to zero. This must be achieved in such a manner that there must be no interaction between any of the F.D.U's when they are running normally, and furthermore the "Start" and "Stop" pulses injected into the F.D.U's must be introduced in such a way that the entire trigger and discharge circuits function in the normal way on returning the potential across C_2 to its zero reference level—*i.e.*, the extinction potential of the thyratron.

To meet the above requirement it is necessary to apply a pulse of short duration and of magnitude equal to, or slightly greater than, the triggering level potential to be

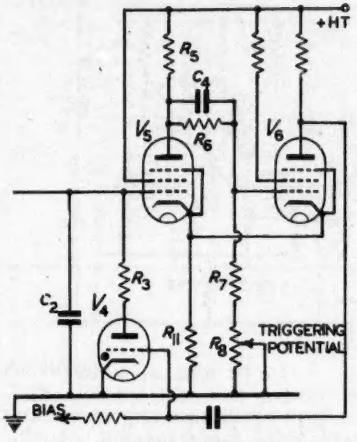


Fig. 8. Trigger circuit

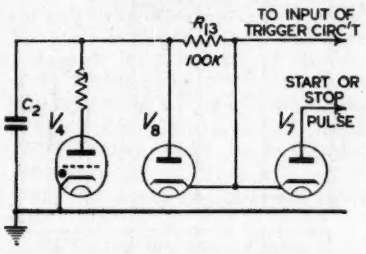


Fig. 9. Cancelling circuit

applied to the input grid of the trigger circuit V_5, V_6; this is accomplished by applying the "Start" and "Stop" pulse through a diode V_7 connected to the trigger circuit (Fig. 9).

It is essential that the 100 kilohm resistor be included in the circuit as shown, or the "Start" and "Stop" pulse will be heavily damped by the capacitor C_2. To ensure that the discrimination of the trigger circuit is not adversely affected by an impedance between C_2 and the trigger circuit input grid, a diode V_8 is placed in shunt with the 100 kilohm resistor as shown, so that there is a low impedance path from C_2 to the input grid of the trigger circuit, while the high impedance in the reverse direction is maintained.

(b) Input Amplifier V_1

The amplifier V_1 consists of an EF.50 pentode connected as in Fig. 10 where the complete F.D.U. arrangement may be studied. The purpose of this valve is to provide a positive output pulse of approx. 350 V when a negative pulse of amplitude 60 V is applied to the grid. This pulse is sufficient to drive V_1 to cut off. The arrangement is slightly modified in the case of F.D.U. in the "Start" and "Stop" channels.

(c) Cathode Follower

It is essential to use a cathode follower to isolate the cathode-ray tube input circuit from C_2, otherwise the load on C_2 causes a deterioration in the waveform. The valve used is a DH.63, since this valve has a high input impedance and a high μ factor.

(d) Brightener Circuit

The marker pulse produced by the trigger circuit V_5, V_6, is too narrow by about 3 μS. to be applied directly to the Y-plate of the cathode-ray tube indicator, and as such is not easily visible at the lower frequencies. Accordingly a "brightener" circuit is introduced, consisting of a conventional A.C.-D.C. flip-flop circuit, (Fig. 11), the width of the pulse output being adjusted by varying the A.C. cross-coupling capacitance between anode and grid.

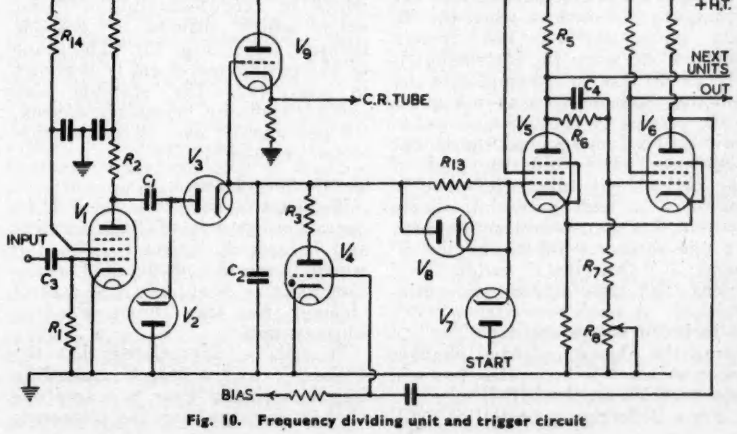


Fig. 10. Frequency dividing unit and trigger circuit

It should be noted that the output pulse is taken from the screen, V_6, since the thyratron V_4 damps the pulse from the anode so heavily (refer to Fig. 10) that the operation of the " brightener " circuit might be impaired.

(e) Cathode Ray Tube Indicator Circuits

The cathode-ray tubes used for indicating the phase difference between units are Air Ministry Type VCR.139A selected for their small physical dimensions, low operating potentials and easy availability. The beam-forming electrodes on each tube are fed from a conventional potentiometer network, the final anode and unused deflector plates being returned to earth and the grid-cathode end of the potentiometer being returned to a common negative high tension line. Pre-set potentiometers are provided to vary the first anode and grid potentials for individually adjusting the focus and brilliance of each tube. A further pre-set potentiometer is also included in series with the main divider potentiometer in order to adjust the final anode voltage (and hence the deflector plate sensitivity on each tube); this in order that the horizontal trace may be lined up with the graduations marked on the tube face. The graduation marking or graticule on the tube face may be of any convenient form which permits the stationary part of the scanning wave form and also the position of the marker pulse and hence the time interval to be read without ambiguity.

Brightening Circuit

To lengthen the life of the cathode-ray tube screens, some switching arrangement is necessary so that the tubes are switched on when the input pulse arrives, but remain blacked out when the instrument is cancelled—this is accomplished by splitting each network as in Fig. 12.

On receipt of the " Stop " pulse, switch " S " closes and shorts out resistance " R "—thus the grids of the cathode-ray tubes are made to approach cathode potential. Beam current flows, and the traces appear on the screens. When the instrument is " Cancelled," switch " S " opens and the traces are extinguished. A small capacitance " C " is included across resistor " R " to damp the abrupt potential changes when switch " S " operates, to avoid any reaction on the F.D.U's.

For a deflection potential of 150 V

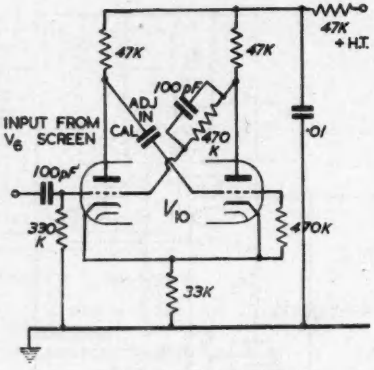


Fig. 11. Brightener circuit

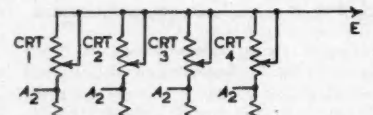


Fig. 12. Blackout circuit for C.R. tube

the trace amplitude is approx. 4 cms., obtained with a final anode voltage of 600 V.

(f) Master Oscillator

The system used is a 200 Kc/s. crystal controlled oscillator to which is locked a 100 Kc/s. multivibrator, which in turn feeds into a buffer stage which utilises a cathode follower valve (Fig. 13). The shape of the output waveform is as shown in Fig. 14. The stability and accuracy of the crystal is approx. 2-3 parts in 10^6 over a temperature range of 20-40° C.

(g) Pulse-forming Unit

The control circuit for the F.D.U. operation consists of Pulse-forming and " Lock-off " circuit (Fig. 15), which is worthy of detailed attention as it is essentially the control element for the Direct Reading Chronoscope.

It will be appreciated that the " Start " and " Stop " cancelling impulses should have a magnitude slightly greater than the triggering level of the F.D.U's since a margin of safety must be allowed. As previously mentioned, " Start " and " Stop " pulses are derived from the boundary conditions of the input time interval. These pulses must be positive pulses of magnitude greater than 200 V with a pulse width not greater than 5 μS.

The Pulse-forming Unit must, therefore:

(1) Accept the boundary pulses of the time interval and convert them into " Start " and " Stop " pulses of the type mentioned above.

(2) " Lock-off " after one pair of pulses defining a time interval have entered the circuit, so that other pulses cannot be accepted until the pulse-forming units have been re-set.

(3) Control the C.R.T. indicators so that on receipt of a time interval, traces appear on the tubes.

The " Start " and " Stop " pulses entering the pulse-forming circuits are dealt with separately, that is to say, there are two completely separate channels, one dealing with " Start " pulses and the other with " Stop " pulses. Each channel may be divided into two sections comprising:

(a) " Lock-off " circuit.
(b) Pulse-shaping Circuit.

and the operation of these is as follows:

(a) Lock-Off Circuit (Start Channel)

The time interval boundary pulses are negative pulses with a magnitude of 50 V or more. The " Lock-off " circuit must, therefore, be of such a nature that one such negative pulse is sufficient to cause the circuit to produce a wavefront and also reject any following negative pulses.

The circuit used for this purpose consists of a trigger circuit, V_{16}, V_{17}, as shown in Fig. 15. V_{16} is normally conducting and V_{17} is cut off. On receiving a negative pulse, V_{16} is cut off and a positive wavefront appears at V_{16} anode; this is transmitted to V_{17} control grid via a potentiometer R_2, R_4 and R_7 (C_2 is included to accelerate the action of the circuit) and causes V_{17} to conduct. Coupling also exists through the common cathode load R_8, as in the Schmidt trigger circuit described previously. A negative wavefront is produced at the anode of V_{17}, and V_{16} is held in a non-conducting state by the potential divided network R_9, R_3, R_6. Hence any further pulse appearing at the suppressor grid of V_{16} cannot affect the circuit until it is re-set.

This is accomplished by opening the connexion between R_8 and earth, when V_{16} grid will become positive in respect to cathode. V_{16} again conducts, the cycle is reversed and V_{17} is returned to its original cut-off condition. The positive wavefront formed at V_{16} is fed via C_4 to V_{18} where it is shaped into a "Start" pulse.

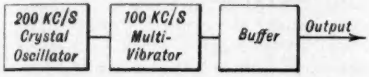


Fig. 13. Arrangement of master oscillator

(b) Pulse-Shaping Circuit (Start Channel)

The wavefront from Fig. 13 anode is converted into a 3 μS. wide positive pulse by the network C_4, R_9 on the control grid of V_{18}, a pentode biased beyond cut-off. The output from V_{18} anode is fed to V_{19}, a limiting amplifier, which produces a pulse of approximately 280 V amplitude at its anode. This pulse is passed to a cathode follower V_{20}, whose cathode is directly connected to the cancelling diodes in the "Top" section F.D.U's. The pulse actually produced by the cathode follower is of the order of 250 V amplitude and has a width of approximately 3 μS. The circuits used for the "Lock Off" and "Pulse Shaping" for the "Stop" Channel, are identical to those described above except that a relay is included in the screen of V_{17}, to operate the cathode-ray tubes after the "Stop" pulse has been received.

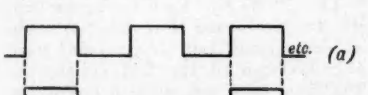


Fig. 14. Oscillator and buffer output waveform

(c) Power Supplies

The power supplies are standard with full-wave valve rectification for H.T. supplies. Separate transformers are used for 6-V and 4-V low tension lines to the F.D.U's. The H.T. for the F.D.U's, and also for the last three valves in each of the two pulse-shaping circuits, is obtained from the main 400 V transformer, but the input sections of the pulse-shaping circuits and the 100-Kc/s. oscillator derive H.T. from a separate 300 V source. The 20 V bias line is supplied from a selenium rectifier, and is resistance-capacity smoothed.

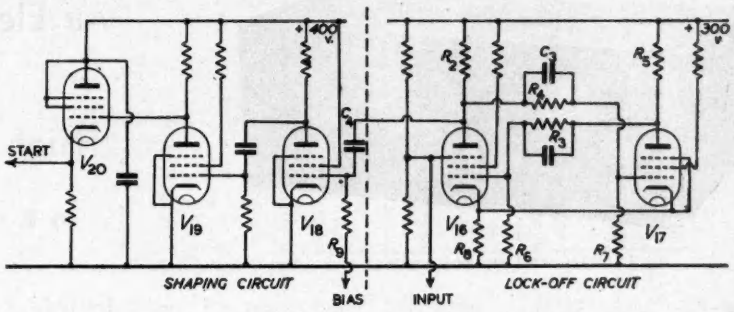


Fig. 15. Lock-off circuit

Application

The counter described and others mentioned in the text offer a medium whereby the physicist, electronic engineer, and industry may determine very accurately any process directly or indirectly related to time. Counters of the type described have been used for a number of applications where other methods are inapplicable and a few of the uses are:

(1) Timing measurements using photo-electric cells as a transfer medium.

(2) Frequency measurement (Ref. 23).

(3) Switch operation timing.

(4) Timing operations associated with radar technique, Loran, etc.

(5) Fuse timing.

(6) Reverberation.

(7) Measurements related to strain and displacement in civil engineering.

(8) In connexion with computing devices similar to the ENIAC.

The above are applications which in themselves warrant attention but the facility and scope of the device particularly manifests itself in regard to (8) above, where developments as recently described in connexion with the ENIAC[24] which utilises counter circuits termed "accumulators" in a similar manner, are likely to become of increasing importance. Further, the "Health" devices associated with atomic energy research and development consist of counter circuits which effectively respond to the ionization taking place in Géiger Muller tubes. These radiations require, in some cases, high resolving speeds in the recording mechanism for accurate counting and the electronic counter is the obvious instrument for such work.

Acknowledgments

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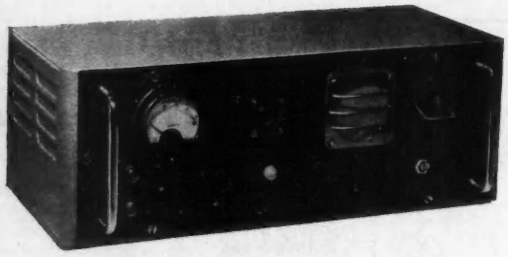

Fig. 1. Front panel view of ionisation tester.

An Electronic Instrument for High Voltage Testing

By E. J. MEMBRY, B.Sc. (Eng.)*

FOR many years it has been common industrial practice to flash-test equipment and components in order to ensure their suitability for the service for which they are intended. As is well known, the requirement is that the item under test should not actually break down under a voltage considerably greater than that at which the item is to be operated.

Existing Test Methods

The usual types of high voltage testing equipment employed in industry suffer from certain fundamental troubles. They are usually dangerous and capable of generating considerable follow-up currents which cause extensive damage on breakdown. All the information which could be obtained during test is not usually presented, there is no indication of impending breakdown, and no opportunity for grading items under test without destroying them exists.

By using electronic techniques it is possible to rectify some of these deficiencies, as will be seen.

An Electronic Ionisation Tester

When the voltage applied between electrodes separated by an insulant is slowly raised, there is a value at which the voltages within the insulant readjust themselves, for instance, when a tiny void breaks down or when ionisation occurs. These changes are accompanied by the flow of very small currents which may be detected by suitable means. This fact is utilised in the apparatus described below.

There are at least four types of voltage used in test apparatus; each has its own peculiarities and gives rise to differing results. These are direct, alternating, radio frequency and impulse voltages. An alternating test voltage is most easily provided since it is merely necessary to provide a suitable transformer with the necessary switchgear. An equipment has been produced using this method of obtaining the test voltage. A special detector circuit, using a resonant circuit to produce a distinctive signal whenever a change in current through the test piece occurred, was employed to give an indication of impending breakdown. This instrument was heavy and bulky, since it had to incorporate effective safety devices which also limited its range of application. Efforts were therefore turned towards a direct voltage test instrument which could be made light, inexpensive, and yet capable of meeting most industrial requirements, with safety and simplicity of operation as fundamental points. The resulting instrument is shown in Fig. 1 and its circuit in Fig. 2.

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High Voltage Source

The first requirement is a source of fully controllable direct voltage, the upper limit of which is determined by the maximum required to test the best components or equipments in ordinary industrial use, at least to their working voltage, but not necessarily to their ultimate breakdown. It was felt that 5 KV would probably meet the great majority of test requirements, and this was made the upper limit of the instrument described.

A considerable saving in bulk and weight can be made by using a radio-frequency supply to the rectifier in place of the more common 50 c/s. supply, since the smoothing capacitors will then be very small both physically and electrically and their energy storage correspondingly limited. Also an R.F. generator producing a suitably high voltage can be designed which will operate from the power supply used to drive the detector amplifier. The design will not be discussed as there are several articles of recent date which are devoted to this subject.

Curves of load voltage against load resistance, and current against resistive load are shown in Figs. 3 and 4 respectively. From these curves it is seen that the current is effectively limited to a value which can cause nothing more than serious discomfort to a careless operator.

Metering and Indicating Circuits

The generator has a high internal impedance and therefore can only be subjected to loads of many megohms resistance if full output voltage is to be obtained. The voltmeter used to measure the voltage is a 100 micro-ammeter of robust construction with a series resistance of 50 megohms of suitable voltage rating. A relatively small resistor (45 kilohms) is included in the earth side of the gap and the voltages developed across this resistor during the test of an item connected in the gap produce the twofold positive indications of the condition of the item concerned.

The "Magic Eye" tuning indicator, so biased that it is normally almost closed, has its grid fed from the live end of the test resistor so that as soon as a direct voltage appears across the resistor the "eye" commences to open; a current of a few microamperes being sufficient to produce a movement. The "eye" gives an indication of the order of the insulation resistance of the item under test, and poor insulants can be distinguished by this indication alone at quite low test voltages. The curve in Fig. 5 shows the threshold of indication for various load resistances.

The live end of the resistor is also coupled capacitatively to an amplifier having a high voltage gain of some 200,000 with a loudspeaker connected in its output circuit. When any minute fluctuating currents flow in the test resistor, corresponding voltages are built up across it

and the amplified signal is heard from the loudspeaker as a hissing crackling noise.

Supposing a reasonably good insulant is being tested, as the test voltage is raised a value will be reached, provided any sign of deterioration occurs within the range of the instrument, at which a slight hissing is audible from the speaker. This is the first sign of the onset of breakdown in the insulant, and as the voltage is raised the hissing becomes louder and higher in pitch until as the tuning indicator opens rapidly a "plopping" noise is heard and the applied voltage snaps down. With a self-healing insulant the discharge may be intermittent until the voltage is raised sufficiently to maintain continuous breakdown.

Under normal conditions, therefore, considerable warning is given before flashover occurs, since the voltage usually has to be increased by a large amount after the first hissing is heard, and it is not necessary actually to cause the item under test to break down. It would seem to be possible, using this method, to classify items according to what, for want of a better term, could be called their "Ionisation Potential."

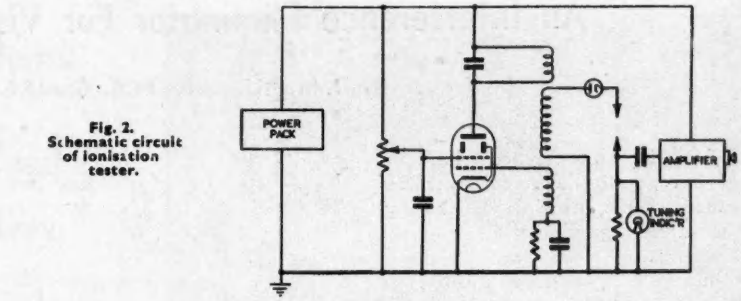


Fig. 2. Schematic circuit of ionisation tester.

Applications

With wider experience of the testing of components with this equipment, it will, no doubt, be found that the ionisation potential bears a fixed relation to the working life of the insulant or component when subjected to a given voltage, so eliminating the need to perform life tests on random samples.

There is no doubt that this instrument can be used for a widely varying range of applications where insulating materials are employed. For example, it may be used to test capacitors, transformer windings, electric motors and cables without the need to damage severely or destroy the test sample.

Breakdowns to earth are not checked by such a straightforward approach unless the item under test can be isolated from ground by the use of, say, wooden blocks, the test being carried out between the windings and the parts normally earthed. By sacrificing the magic eye indication, however, the audible signals of impending breakdown to earth can be received by connecting the test lead via a small high quality high voltage capacitor to the high voltage lead. Usually it will be practicable to use the first method, especially as the insulation resistance required of the blocks employed is not high, a value greater than 45 kilohms being all that is necessary.

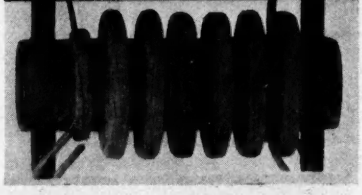


Fig. 6. Detail of R.F. transformer used, showing simplicity of construction.

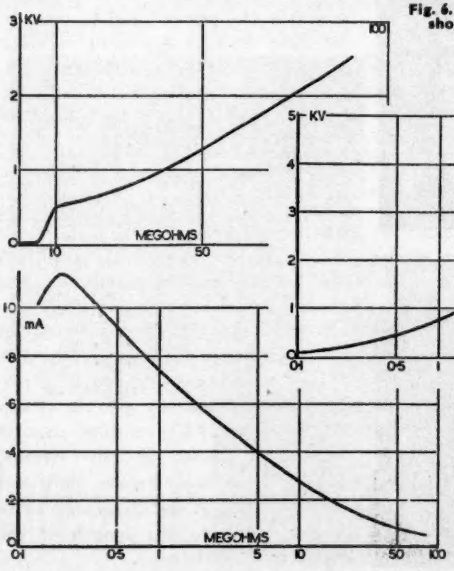


Fig. 3. (Above) Load voltage v. load resistance and Fig. 4 (left) current against resistive load.

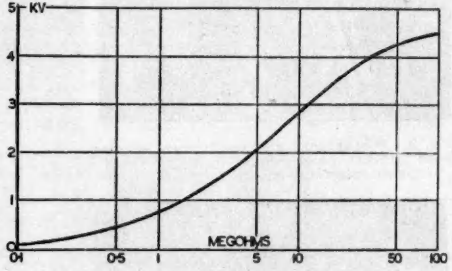


Fig. 5. (Top left) Threshold of indication for various load resistances.

Conclusion

An instrument has been developed which is likely to change materially high-voltage testing methods. It enables the presence of ionisation in a component when subjected to a direct voltage to be detected. The voltage at which ionisation commences can thus be determined, and it is anticipated that in many instances it will be possible, with experience, to correlate this voltage with other properties; for example, the safe working voltage, the result of flash-testing, etc. The instrument is small, light, simple and safe to use, and relatively cheap. Although the instrument described is limited to voltages up to 5 KV, there should be no great difficulty in extending the range several times should a need arise.

The writer wishes to express his thanks to Dr. J. C. Simmonds, under whose direction this development was carried out.

References.

[1] R. S. Mautner and O. H. Schade, *RCA Rev.*, March, 1947; also O. H. Schade, *Proc.I.R.E.*, April, 1943.

An Interference Eliminator For Vision Receivers

By D. McMULLAN, M.A. Grad.I.E.E.*

VISION interference limiters have, up to the present, operated either on the principle of limiting the interfering pulses to peak white, or inverting pulses having amplitudes greater than peak white so that they appear as black spots. The circuit† described below is designed so as to maintain the brightness of the scanning spot at the value it had immediately prior to the arrival of a pulse of interference. The effect on the picture is that when a pulse of interference occurs while a part of uniform brightness is being scanned, such a pulse will not be visible. If a pulse occurs just before and persists while there is a change, say, from black to white, the black will be carried over the boundary. The detail of the image is therefore broken up by interference, but on those parts of the picture which have little or no detail the pulses are not seen.

A simplified circuit diagram of the device is shown in Fig. 1. The signal from the video frequency amplifier is passed through the delay line *LC* and is applied to a gate circuit made up of diodes D_1 D_2 D_3 D_4 and from there to the modulator of the cathode-ray tube. The gate is open when the cathodes of D_3 D_4 are taken to a negative potential through a resistance and the anodes of D_1 D_2 to a positive potential, and is closed when these potentials are reversed. The opening and closing of the gate is controlled by the cathode coupled amplifier *V1A-B* which is so biased (*V1A* non-conducting, *V1B* conducting) that the gate is normally open and the video signal is fed to the cathode-ray tube. Interfering pulses of greater amplitude than peak white are separated from the video signal by the diode *D*5 and applied to the grid of *V1A* causing

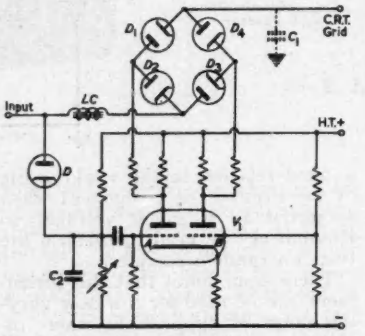


Fig. 1. Simplified circuit diagram of interference eliminator

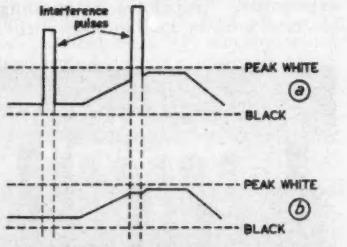


Fig. 2. Typical video waveform with interfering pulses at input of circuit (a) and pulses removed at output (b)

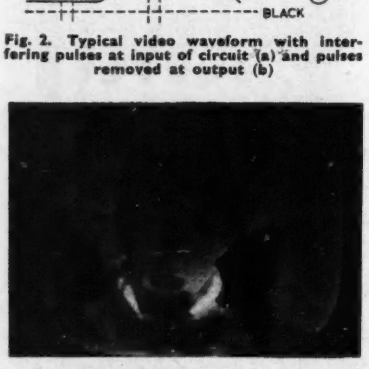


Fig. 3. Photographs of screen images. Above: with normal peak white limiter; below: with interference eliminator fitted

this triode to conduct and cutting off *V1B*, thereby closing the gate. The potential of the modulator remains at the value it had immediately prior to the closing of the gate due to the charge stored in C_1, its stray capacity, which may with advantage be increased with a small condenser. At the end of the interfering pulse *V1A-B* resume their normal condition and the gate is opened. The delay line is incorporated in order that the gate may be closed by any pulse before that pulse reaches the gate with the video signal, and the opening of the gate at the end of the pulse is delayed by C_2 so that the gate only opens after the end of the pulse has reached the gate. Fig. 2 shows typical waveforms at the input and output of the device.

Of course pulses of smaller amplitude than peak white will not operate the device, but this has not been found serious in practice as the majority of ignition pulses are of large amplitude. However in some cases it might be worth while to derive the pulses used to operate the gate from a separate receiver either tuned to a different frequency or connected to an aerial so arranged as to pick up only the interference.

The photographs (Fig. 3) were taken simultaneously from two cathode-ray tubes fed from the same vision receiver, one having a normal peak white limiter fitted and the other fed through the device described above. The receiver was situated 45 miles from Alexandra Palace and heavy ignition interference was present at the time. The photographs give some idea of the effectiveness of the circuit, although the interference does not show up in Fig. 3a as clearly as in practice, due to the length of the exposure (1/5th sec.).

* Cavendish Laboratory, Cambridge
† British Prov. Patent

Mechanical Problems in the Use of Glass-Based Valves

By
H. L. BOWEN*
and
D. N. CORFIELD*

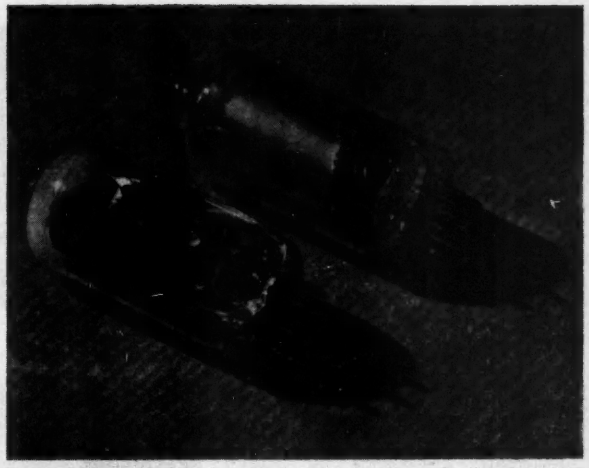


Fig. 3. The result of forcing glass-based valves into mis-aligned contacts

THE introduction of valves on miniature all-glass bases such as the B7G and B8A brings in its train not only technical problems in ensuring that the fullest advantage is taken of their high performance, but also mechanical problems in securing good contact between the small diameter pins and the corresponding contacts in the valve holder, and in avoiding risk of damage to the valve when it is inserted into or withdrawn from the holder.

It is scarcely necessary to mention the troubles resulting from faulty contact. An open circuit on a single pin will, of course, usually render the valve inoperative and, at the worst, may cause severe damage to the valve itself. Intermittent contacts usually result in noisy operation; and a high resistance contact will undoubtedly reduce the performance of the valve.

Adequate contact area and pressure were easy to achieve in the old days of substantial solid or "banana" pins and massive valve holders, and British Standard No. 448:1947 lays down the maximum contact resistance, or alternatively, the maximum permitted voltage drop between valve pin and contact which will ensure satisfactory operation. But the newer types of valve have pins of very small diameter, very closely spaced, and for this reason, and also to avoid the presence of large masses of solid dielectric, valve holders must be of miniature and light construction.

It has not yet been possible to provide a satisfactory specification for contact resistance for "all-glass" bases. The problem of securing satisfactory contact resolves itself into a matter of ensuring that the spacing and alignment of the valve pins is maintained within the original manufacturing tolerances, and that the contacts in the valve holder are accurately spaced within the same tolerances.

If these conditions are not maintained, not only is faulty contact likely to result, but there is a considerable risk that, in forcing the valve into the holder, the glass base will be fractured and the valve ruined.

Two types of valve pins are at present in use. One type is of hard chrome iron, and the other is of nickel which is comparatively soft. It may be taken for granted that, as delivered from the factory, the valve pins conform to the specification as regards position and spacing. But by the time a valve provided with soft pins is finally installed in the receiver, much may have happened to render these dimensions inaccurate. The valve may, for instance, be inserted and withdrawn several times while the receiver is being tested or serviced; or it may be subject to rough treatment while lying on the bench, or even in stock.

Pin-Straighteners

The only certain method of ensuring that the valve pins are satisfactory is the use of a pin-straightener, for all valves having soft pins, immediately before inserting the valve in its holder.

* Members of the B.V.A. Technical Committee.

Fig. 2. Pin-straightening tool in use

Fig. 1. Pin-straightening tool

Having disposed of the problem of valve pins, it is then necessary to make equally certain that the valve holders are blameless. It is very desirable that the contacts in the valve holder should have provision for "float," that is to say, they should have a degree of freedom of movement so that they may accommodate themselves to the positions of the valve pins. But there is then a chance that while the wiring is being soldered to the valve holder, the contacts may be pulled completely out of alignment, and any attempt to force the valve into the holder carries a grave risk of valve breakage.

There are, of course, some forms of valve holder in which the soldering tags are anchored mechanically while still giving the contacts the necessary degree of "float," but in most cases both tag and contact have freedom of movement. It is then essential that the contacts be securely held in their correct relative positions while the wiring is being soldered to the tags.

Displacement of the contacts may be due to the use of stiff or heavy gauge wire for soldering, but is, more often than not, the result of wiring components directly to the valve holder tag, or to the bad practice of bending tags down to the chassis, or to other parts for direct earthing. Incidentally, the use of heavy gauge wire is quite unnecessary in ordinary receivers; it is only required in U.H.F. circuits, that is to say, for frequencies well above the normal short wave broadcasting range.

Wiring Jigs

The solution, of course, is to insert a jig of some kind in each holder while the set is being wired, and this should be done whether the valves to be fitted have hard pins or soft pins.

A spare or defective valve is often used for this purpose but this practice is to be deprecated. A valve so used may be on either limit of its dimensional tolerance and may become outside the tolerance after a short period of use, even if it is of the type employing hard pins, so that the socket contacts may be held out of alignment during soldering. A proper wiring jig employing accurately spaced hardened steel pins is therefore essential.

The necessity for pin-straighteners and wiring jigs was recognised by the Services during the war, and

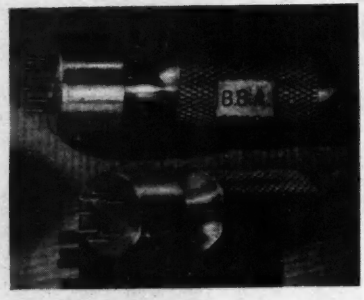


Fig. 4. Forms of soldering jig

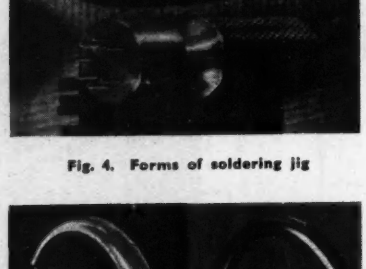


Fig. 5. Wire grip type of valve remover

suitable tools were imported from the U.S.A. under "Lease-lend" and issued to manufacturers. In other cases some manufacturers constructed their own tools at considerable expense.

A drawing of a pin-straightening tool for valves on the B7G base is given in the appendix to British Standard 448:1947. Drawings for tools for other glass based valves will be included in a revision of this specification now being prepared. It is therefore of interest to record that a range of pin-straightening and soldering jigs has now been placed on the market. These conform to the British Standard tolerances either already issued or to be contained in future editions on revision of this Standard.

Valve Removers

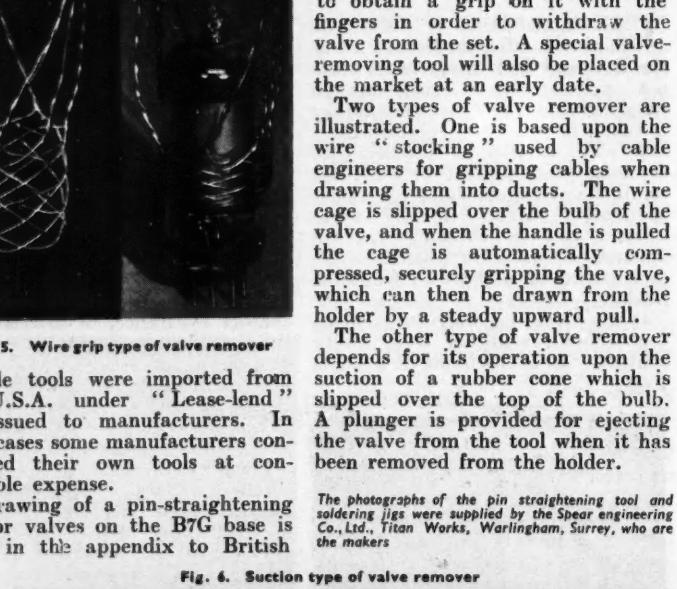
Not the least important of the advantages of miniature all-glass valves is their very small dimensions, making possible the design of extremely compact chassis. In this connexion, however, another mechanical problem arises in that the valve, once inserted in its holder, is often so hemmed in by other components that it is very difficult to obtain a grip on it with the fingers in order to withdraw the valve from the set. A special valve-removing tool will also be placed on the market at an early date.

Two types of valve remover are illustrated. One is based upon the wire "stocking" used by cable engineers for gripping cables when drawing them into ducts. The wire cage is slipped over the bulb of the valve, and when the handle is pulled the cage is automatically compressed, securely gripping the valve, which can then be drawn from the holder by a steady upward pull.

The other type of valve remover depends for its operation upon the suction of a rubber cone which is slipped over the top of the bulb. A plunger is provided for ejecting the valve from the tool when it has been removed from the holder.

The photographs of the pin straightening tool and soldering jigs were supplied by the Spear engineering Co., Ltd., Titan Works, Warlingham, Surrey, who are the makers

Fig. 6. Suction type of valve remover



The Paris Television Convention--1948

THE "Congrés de Télévision," organised by the Société des Radioélectriciens, was held in Paris during the week October 25-30. A full programme of over 30 technical papers and five organised visits was completed, and the following brief account deals with those items which appeared to hold the greatest interest at the time.

Technical Papers

Many of the papers of a predominantly theoretical or speculative type do not admit readily of abridgement and must be studied in their entirety. The majority of these papers appear in somewhat shortened form in *L'onde électrique* for October; also it is understood that the Society intends to publish a volume containing the complete transactions of the Convention, including the discussions.

Prof. A. V. Castellani, president of the Italian National Technical Committee on Television, lectured on his conceptions of the future Italian television network, involving U.H.F. links, backed by a line network carrying synchronising data from a central source, and discussed the possibility of this becoming part of an eventual west-European network. As a rejoinder to those who regard such an idea as impracticable, it is well to add that the Italians have already done work on mountain-top relays (illustrated by slides in the lecture) and while it is obvious that much remains to be done, the achievements to date are noteworthy.

The paper by A. Cazalas (Compagnie des Compteurs) "La Projection sur Grand Ecran des Images de Télévision" was of interest in the results obtained by this company at its teleciné demonstration, to which reference is made later.

H. Gutton and J. Ortosi (Research Laboratory of the Compagnie Generale de T.S.F.) described a novel method of wide-band modulation of U.H.F. carriers. A 23-cm. transmitter, mentioned later, consists essentially of two cascaded power klystrons, master-oscillator and output stages. Direct modulation of the output stage is clearly impracticable, especially in view of the wide pass-band (± 15 Mc/s.) required for a picture of 819 lines used by C.S.F., so a magnetron modulator is coupled into the waveguide connecting the power stage to the radiating horn. Modulation then takes place by varying the waveguide impedance locally and causing reflexion in the guide. By taking advantage of the wide variations of the impedance of the magnetron with anode voltage, practically linear modulation is obtained throughout the range of carrier amplitude.

G. Rabuteau, director of the "Laboratoire Central de Télécommunications," spoke on transmission by ultra-short-wave beams and gave an account of the development of wide-band power amplifier tubes. The performance of the latest tube of this type, the "two-stage" klystron L.C.T.-3863-A, operating at a mid-frequency around 2,500 Mc/s., is claimed to be as follows:—

Bandwidth	Mc/s.	Mc/s.
(− 3 db.)	30	50
(−0.1 db.)	10	15
Output watts	10	5
Gain	25 db.	20 db.

Those who came into contact with the very original work of the late Dr. Fischer of Zürich on the "Eidophore" were glad to hear the comprehensive paper given by Dr. H. Thiemann, bringing up to date the information on this outstanding development. Dr. Thiemann and his associates have made further valuable contributions, in particular by shortening the "memory" of the device, which in the earlier versions tended to be too long for satisfactory results.*

The absence of papers on general receiver problems was remarked. This was no doubt due to the fact that the receiver industry has not yet had much opportunity to get into its stride on a production basis.

Visits

The first of the organised visits was to the new Television Centre of the French broadcasting service in the Rue Cognac-Jay, about ½-mile from the transmitter at the foot of the Eiffel Tower. Several large transmitting studios are in course of preparation and it appears that the facilities will be very considerable when the work is complete. However, another year or so will be required to bring the project to completion. A model of an interesting "Grue de Camera" was exhibited, permitting to the producer three-dimensional camera movement.

An experimental system for television "in relief" was shown in which the two images appear vertically one above the other on the screen of a single C.R.T. This is viewed through a simple lens system which restores the aspect ratio and gives apparently bi-optical vision. Quite convincing results were shown.

Also at the Television Centre was a small exhibition at which were shown U.H.F. and camera tubes of many types, together with various pieces of specialised apparatus, generally with a U.H.F. interest. Philips, C.S.F., Cie des Compteurs, SADIR, French Thomson-Houston and Les Laboratoires Radio-Electriques exhibited.

The Compagnie des Compteurs at Montrouge staged a closed-circuit demonstration of their 1029 line system, using film transmission. The mechanical and electrical excellence of this gear is quite impressive, but it seems that the pick-up arrangements now used are incapable of doing justice to a 1,000-line system—a remark which applies to most of the high-definition systems demonstrated. Also, the wide bandwidth of the system (of the order of 20 Mc/s.) resulted in an appreciable amount of random noise visible on the screen.

The C.F.T.-H. showed an experimental system working with a nominal 729 lines, but it appeared that limitations in the iconoscope prevented realisation of the expected definition.

The Philips company demonstrated its well-known 30 by 40 cm. projection receiver on a transmission of 567 lines, a standard favoured by this company. Very satisfactory pictures were shown.

Also seen were the mobile relay equipments of Sadir (455 lines) and Radio-Industrie (819 lines). Both impressed with their compact and workmanlike appearance and comprehensive facilities.

In conclusion, it is pleasant to pay tribute to the hospitality and unfailing kindness of the secretary and officials of the Société des Radioélectriciens during a most enjoyable week.

R. G. CLARK

* See ELECTRONIC ENGINEERING, p.362, November, 1948.

Applications of Alternating Current Amplifiers to Optical Measurements

By E. J. HARRIS, Ph.D.*

THE quantitative study of the emission and absorption of energy in the optical region of the spectrum, which we may take as extending from 0.2μ in the ultra-violet to 14μ in the infra-red, and the application of absorption measurements to practical problems frequently requires either the detection of low energy levels or the accurate matching of an unknown energy flux to an adjustable standard. This article discusses the application of A.C. amplifiers in certain examples.

There are many cases when a combination of a barrier-layer photocell, acting as detector, and a galvanometer to measure the output, provides sufficient sensitivity so that no amplification is necessary. The familiar luxmeter which measures intensity of illumination, and photo-electric colorimeters used in chemical laboratories to match a coloured solution with standards of known strength, are good examples. However, when a more accurate measurement or match is required, the following limitations appear: (a) the sensitivity of the cell is not constant and depends on its previous treatment; (b) changes in intensity of the energy source (*e.g.*, the lamp) may take place between making the observations; and (c) to obtain high sensitivity a D.C. amplifier is necessary, and the system becomes sensitive to changes in supply voltages, and also to the presence of any stray light which leaks into the apparatus. The latter effect can be reduced by interrupting the beam of radiation before it enters the optical apparatus and using an alternating current amplifier to follow the detector. Then the D.C. level is not observed, and supply voltage alterations have little influence on the output. In order to remove limitations (a) and (b) it is necessary to make use of a common source and detector and always to refer the absorption to a standard, such as that provided by an optical wedge. By designing the system so that the energy reaches the detector alternately via the specimen whose absorption is to be found, and via the adjustable attenuator (wedge) we shall obtain an alternating component from the detector unless the absorptions happen to be equal. If the attenuator is set manually or automatically so that the absorptions are equal, the unknown absorption is measured in terms of the attentuator setting.

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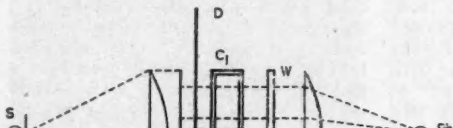


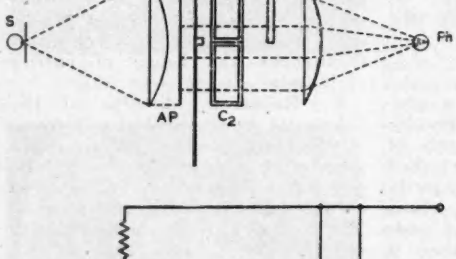
S—light source. A.P.—aperture plate. D—rotating disk. C_1 and C_2—cells to contain specimen and blank solutions. W—optical wedge. Ph—photo-cell.

Fig. 1a (*upper left*). **Photo-electric absorptiometer**

b (*above*). **Detail of disk and aperture plate. The angular spacing between the apertures is equal to the angle subtended by one hole plus one blank at the axis of the disk. The apertures themselves subtend an angle at the axis equal to that subtended by the holes of the disk**

c (*left*). **Tuned amplifier for use with the instrument. The output is observed either by use of headphones or an a.c. meter**

—*from The Journal of Scientific Instruments.*



In photometry we may wish to find the intensity of one source in terms of that provided by a standard. In this case the sources can be arranged to illuminate the detector alternately, and a balance obtained by interposing a calibrated attenuator in the more intense beam. The source intensity is then measured in terms of the attenuator calibration. For work in the infra-red it is not possible to use an ordinary glass wedge, so an adjustable vignette is substituted. The transmission of the vignette can be made proportional to the open area, provided the width of the opening is greater than a few wavelengths of the radiation whose energy is being observed.

When measurements are required in the ultra-violet or visible regions of the spectrum at low energy levels the photo-emissive type of photocell is the best form of detector. It is only about 1 per cent. efficient in converting light quanta to free electrons, but nevertheless the minimum detectable energy is as little as 10^{-13} watts (for a reading taking one second).[1] Work in the infra-red is more difficult because an intense source is not available, and the detectors, either bolometers or thermocouples, are less sensitive. The limiting energy for signal equal to noise, using period of one second is about 10^{-10} watts, but this is seldom attained in practice.[2]

Recent work on photo-conductive materials, such as lead sulphide, has improved the possible performance for wavelengths up to about 3μ.[3]

Before going into more detail let us consider three examples of apparatus using A.C. amplification. Fig. 1 illustrates[4] an absorptiometer or colorimeter in which the energy is switched between the two optical paths by means of a slotted disk

reminiscent of the early television disks. The aperture plate carries two holes which define the maximum path area, and provide, with the circular holes in the disk, a fair approximation to a sine wave output when the absorptions are not balanced. In order to obtain zero signal at balance the total area illuminated must remain constant during rotation of the disk. The amplifier is tuned to the interruption frequency and by use of a narrow bandwidth both noise and sensitivity to external influences are reduced. The interruption frequency is equal to the product of the number of holes in the disk and the rate of rotation; it is, of course, necessary to hold the speed sufficiently constant to keep the interruption frequency within the pass band of the amplifier. An instrument of this kind can be used to provide quantitative data on solutions which are colourless to the naked eye.

Infra-red Spectrometer

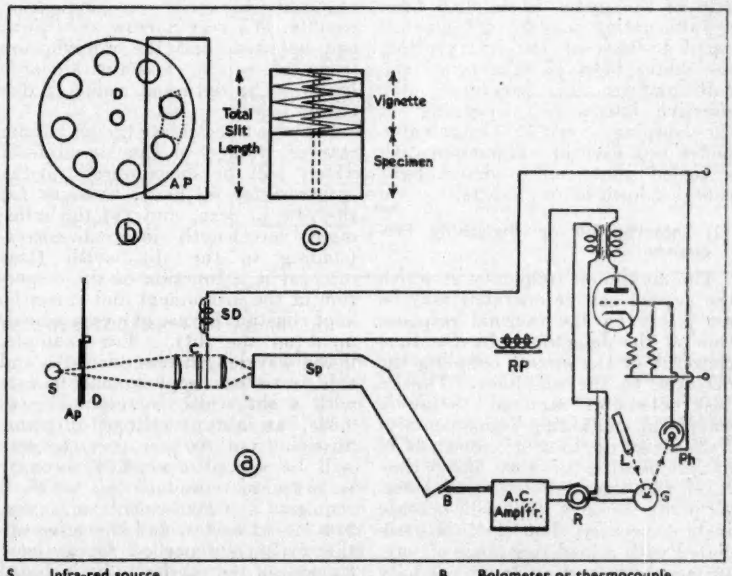
As the second example the infra-red spectrometer of Fig. 2 may be cited. In this instrument[6] a single path for the energy is used, but the material whose absorption is to be measured only obscures half the total area of the slit, and an adjustable vignette is interposed before the other half of the slit area. The rotating disk causes the energy beam to pass alternately via the specimen and the vignette. The emergent energy is focussed on to a thermocouple, the alternating output from which is a measure of the unbalance between the two paths. The alternating waveform is rectified by a mechanical rectifier driven by the interrupter, and after amplification by the photo-cell galvanometer combination the output is used to operate the vignette in such a way that the A.C. amplitude is reduced to a minimum. The current operating the vignette is also used to actuate a recording pen, so the attenuation introduced in order to restore balance is indicated. By driving the wavelength adjustment of the spectrometer from a motor the instrument is made to produce a record of absorption versus wavelength. In order to reduce hunting a velocity feedback is used, by coupling the valve amplifier back to the galvanometer through a transformer.

The accuracy of this instrument is substantially independent of variations of the source intensity, and the detector sensitivity, in distinction to those instruments which do not include a comparison path. The latter type has to be calibrated in order to know the output corresponding to 100 per cent. transmission and one has to rely on the calibration remaining constant between experiments. An example of a single beam spectrometer is outlined in Fig. 3. The alternating component of the output from the detector is demodulated and displayed on a cathode-ray tube against a measure of the rotation of the wavelength adjustment, which is motor driven. This kind of display is rendered possible by use of a detector of short time constant, which may be operated with an interruption frequency of some hundreds of cycles per second. A somewhat similar system in which, however, the output was not demodulated, is described in Reference 6.

The above examples have been chosen to illustrate the applicability of A.C. amplification following use of a switched or interrupted beam. The amplification which can usefully be applied is limited by electrical noise or random fluctuations in supplies; by use of a narrow bandwidth these disturbances can be reduced at the expense of speed of operation. We may now summarise the variables in the detector and amplifier which affect the design.

(1) Detector Impedance

When a photo-emissive cell is used as detector it is best to couple it directly to a valve of high input impedance. The high resistance bolometers, of which the sensitive part is a semi-conductor, can be made to have a resistance of about a megohm, so they can be connected directly to most types of valve amplifier. It is low resistance detectors which require most care if optimum performance is to be attained. Unless the resistance can be transformed up to more than a megohm, the noise from the first valve will greatly exceed that from the detector. If the operating frequency is low, it is necessary to use a transformer of high primary inductance and high turns ratio. Not only



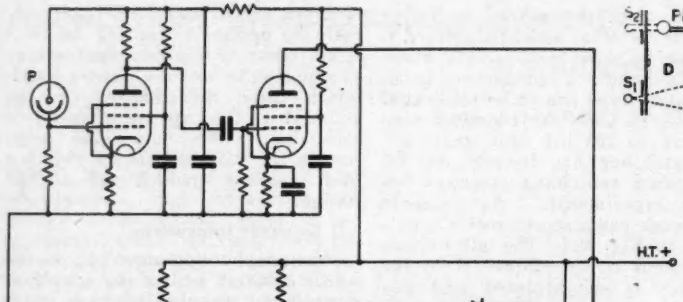
S Infra-red source
Ap Aperture plate
D Rotating disk
C Specimen
S.D. Electromagnetic drive of vignette
Sp Spectrometer
B Bolometer or thermocouple
R Mechanical rectifier
G Galvanometer
L Lamp for galvanometer
Ph Photocell
R.P. Recording pen

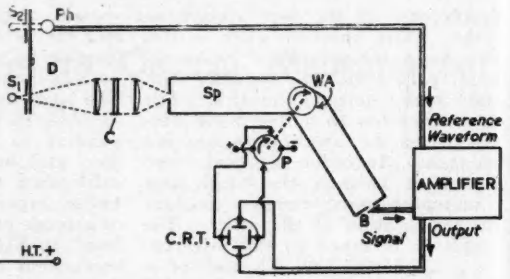
(For infra-red work, mirrors have actually to be used for the focussing system before the entrance slit).

Fig. 2a. Spectrometer having divided optical path and automatic balancing between absorption of specimen and comparison transmissions

Fig. 2b. Detail of aperture plate and rotating disk. The aperture in this case subtends twice the angle subtended by the holes of the disk

Fig. 2c. Elevation showing the division of the optical path between the vignette and the specimen





S_1	Infra-red source	S_2	Lamp
Ph	Photocell	D	Rotating disk
C	Specimen		
W.A.	Wavelength adjustment driven together with P.		
P	Potentiometer providing X-shift		
B	Bolometer or thermocouple		
C.R.T.	Oscilloscope		

Fig. 3 (*above*). **Spectrometer system in which the energy transmission is measured by observing the amplitude of the signal output. The wavelength adjustment is driven from a motor and the absorption spectrum is displayed on an oscilloscope**

(*Left*) **Circuit using "homodyne" system to regain the signal waveform by mixing the signal modulated carrier with a reference waveform derived from a separate lamp-photocell combination**

is such a transformer bulky, but it tends to pick up stray interference. For this reason, better results are obtained at low frequencies by use of a galvanometer matched to the detector. If the field of the meter is supplied from an alternating source, of frequency equal to that of the interruption, the meter behaves as a tuned circuit and rectifier combined, the effective bandwidth depending on the damping. Such an A.C. galvanometer was used in conjunction with a cooled photo-cell to detect light energies down to 10^{-13} watts.[4]

(2) Interruption or Switching Frequency

The maximum frequency at which the system can be operated may be set either by the thermal response time of the detector or by the time constant of the circuit coupling the detector to the amplifier. Thus a fast bolometer can only follow a waveform containing components of frequencies up to some hundreds of cycles because of the finite time taken to warm and cool the element. A photo-emissive cell will operate instantaneously, but if it is associated with a load resistance of, say, 10 megohms, and an input capacity of 30 pF the signal obtained at an interruption frequency of 1 Kc/s. is only 60 per cent. of the zero frequency value of signal amplitude. Both the frequency of interruption and the bandwidth of the amplifier determine the maximum rate at which the signal amplitude can vary and still be accurately reproduced by the amplifier. In order to decide these factors we must find out the maximum rate at which the signal level will change. Static instruments like photometers are not required to give an indication rapidly, so a very narrow bandwidth can be used, and the interruption frequency can be chosen within wide limits. The optimum value is discussed below.

In order to calculate the maximum rate of change of the signal level which will be encountered in the spectrometer we have to know (a) the rate of scan, and (b) the minimum wavelength interval corresponding to the slit width (this interval is a function of the dispersion of the instrument and it can be kept constant by use of a cam adjustment on the slit). For example, if the wavelength range is 1-11μ and this is to be swept in one minute with a slit width corresponding to 0.04μ, an abrupt change of transmission from 100 per cent. to zero will be spread over 0.24 seconds. In order to reproduce this we shall require a bandwidth of, say, $3/0.24 = 12$ cycles, and the interruption frequency needed for at least 3 cycles of the carrier to be included in the steep part of the signal envelope will also be 12 cycles per second. In practice such abrupt changes of the transmission are not encountered, so we are left with a margin of safety. If the scanning rate is too great for the detector-amplifier system to reproduce it, the fine structure of the absorption spectrum is lost (*see* Ref. (7) for illustrations). The short time constant of the semi-conductor bolometers renders them suitable for use with high rates of scan so it is possible to display the spectrum on a cathode-ray tube.

When the interruption frequency is not determined by the maximum rate of response which is required it is generally possible to find an optimum value which will give the highest signal to noise ratio. Particularly when semi-conducting detectors are used it is found that the noise intensity increases as the frequency to which the system is tuned is diminished.[5] Since the signal output from a detector of finite time constant also increases as frequency is diminished, but not following the same law as the noise intensity, it is necessary to plot the ratio of these two variables against frequency in order to find the best value for the working frequency.

(3) Method of Tuning

The possibility of using a resonant A.C. galvanometer has been mentioned. The mechanical rectifier system used in our second example has a discriminating effect for both phase and frequency, so no tuned circuit need be employed. When tuned circuits are used they can be either resistance capacity or inductance capacity combinations; the former prove more convenient at low frequencies, say up to 100 c/s.,

(*Concluded at foot of next page*)

A Simple Modulation Meter

By A. J. MUIR, B.Sc., Grad.I.E.E. and J. W. WHITEHEAD,* B.Sc., M.I.E.E., F.Inst.P.

IN its essentials this device comprises:

(i) A rectifier for radio frequencies.

(ii) A rectifier for modulation frequencies.

(iii) Arrangements for zero setting.

(iv) An indicating circuit.

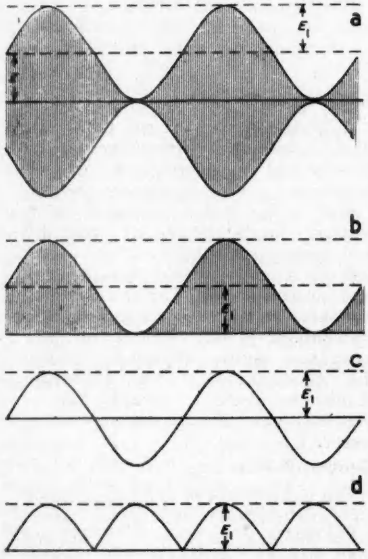


Fig. 2. Signal waveforms in various parts of circuit.

The R/F Rectifier

The modulated input is applied across the potentiometer R_1 (Fig. 1) by means of a short length of wire which serves to couple the meter to the feeders of the transmitter generating the signal. An appropriate portion of the voltage developed across R_1 is applied, in the case of 30-60 Mc/s. transmissions, to a 2-turn inductance L_1 which is coupled to 5-turn main tuning inductance L_2. Both these coils are self-supporting and lie along a common axis. They are ½-in. diameter and are wound with 18 s.w.g. tinned copper wire with a turn spacing of one wire diameter. The inductance L_2 is tuned by a variable condenser C_1 of maximum capacity 100 pF.

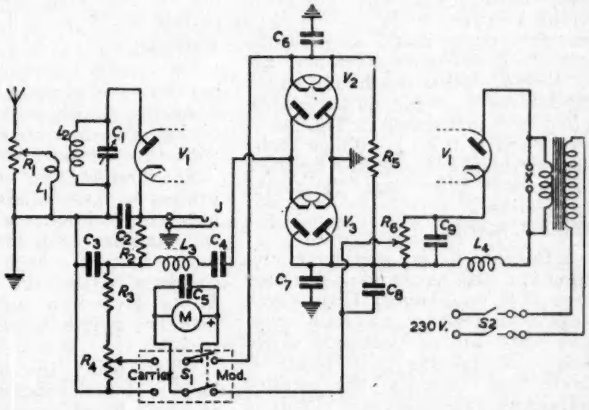
The R.F. input is applied via C_2 to one diode of the 6H6 valve V_1, the load of which comprises R_2, R_3 and R_4 in series. Condenser C_3 acts as a R.F. filter condenser in parallel with R_3 and R_4. The effect of the two capacitors C_2 and C_3 is to produce voltage variations across the R_2,R_3,R_4 combination shown in Fig. 2c. (In

* Leeds Central High School.

Fig. 1. Circuit of modulation meter

Component Values

R_1 = 500 Ω 1W
R_2 = 25K Ω ½W
R_3 = 10K Ω ½W
R_4 = 500 Ω ½W
R_5 = 50K Ω ½W
R_6 = 5K Ω ½W
C_1 = 100pF
C_2 = 100 pF
C_3 = 500 pF
C_4 = 0.5 μF
C_5 = 0.01 μF
C_6, C_7, C_8 = 500 pF
C_9 = 25 μF
V_1, V_2, V_3 = 6H6
L_1 = 2T (½ in. dia).
L_2 = 5T (½ in. dia.)
L_3, L_4 = V.H.F. choke
M = 0-500 Micro-ammeter



A.C. Amplifiers in Optical Measurements—*contd.*

owing to the bulk of large inductances. It is necessary to pay considerable attention to the constancy of the motor speed to keep the signal frequency within the limits of the amplifier when a narrow bandwidth is used. This can be obviated by use of a type of homodyne circuit (Fig. 3b) in which a reference waveform produced by a separate lamp-photo-cell combination is mixed with the signal in a bridge demodulator. The discussion regarding the linearity of the circuit to be found in an article on the Synchrodyne in this Journal applies also to this.[9] No tuned circuit is required, and limitation of pass band is provided by a low-pass filter. The output waveform is suitable for application to the recording instrument or oscilloscope, whereas when a tuned circuit has been employed it is necessary to demodulate unless the carrier is displayed.

Many applications to other kinds of physical measurement have been based on the fact that it is more convenient to amplify alternating E.M.F.s than D.C. levels. A recently described electrometer[10] for the observation of small electrostatic potentials makes use of the alternating E.M.F.s produced on a charged fibre by a reed vibrating in its vicinity in order to find the position of the fibre, which in turn is a measure of the potential. Contact potentials set up between two different materials can conveniently be observed by arranging that one specimen vibrates near the other. The alternating E.M.F. which is set up in the circuit is amplified,[11] and for maximum sensitivity the amplifier is tuned to the vibration frequency.

References

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[2] Hornig and O'Keefe, *Rev. Sci. Inst.*, 1947, 18, 474.
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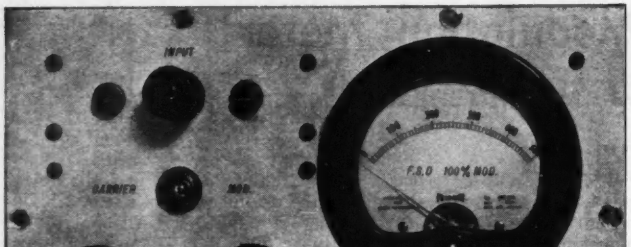


Fig. 4. Front panel of instrument. Overall dimensions are 8¼ in. by 5 in. by 5½ in.

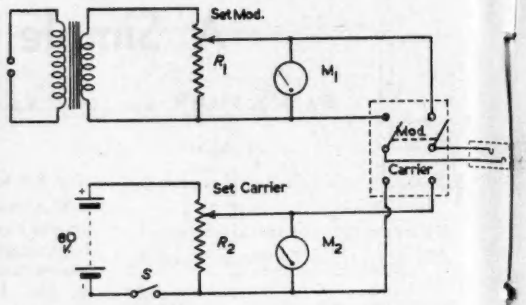


Fig. 3. Calibrating circuit ($R_1 = R_2 = 500K\Omega$)

the absence of these condensers, the variations would approximate to those shown in Fig. 2b). The mean rectified current in R_1, R_2 and R_3 is therefore proportional only to the unmodulated carrier level and not to the modulation depth; and superimposed on this D.C. is the purely audio variation shown in Fig. 2c. A proportion of the A.F. voltage variations developed across R_4 is applied, via the R.F. filter choke L_2, to the A.F. rectifier.

The A.F. Rectifier

A fullwave bridge rectifier circuit using two 6H6 valves (V_2,V_3) is used since it is more linear than a fullwave oxide rectifier, and more sensitive than the conventional single diode. By making C_4 of comparatively large capacity, the rectified voltage approximates very closely to the peak applied A.F. voltage (E_1 in Fig. 2d). Any R.F. components which may be present are rendered ineffective by C_5 and C_7. With the bridge arrangement described, there is a standing D.C. of about 200 μA, and so a circuit is included to balance this out.

The Balancing Circuit

The 200 μA necessary to balance out the standing D.C. of the audio rectifier system is obtained by rectifying the 6.3 volt heater supply voltage with the aid of the second diode of V_1. The output load of this diode comprises a 5,000 ohm potentiometer (R_5) in parallel with a 25 μF condenser (C_5). The movable arm of the potentiometer serves as the balancing control, and adjustment of it enables the standing current registered by the meter M to be set to zero when the switch S_1 is in the "MOD" position.

Resistor R_6 forms the output load of the bridge rectifier unit. Filtering of unwanted R.F. currents is performed by L_1 and C_6.

Calibration

The circuit diagram of a calibrating device is given in Fig. 3. This comprises readily adjustable sources of A.C. and D.C. supplies, together with the necessary meters.

The first step in the calibration process is the adjustment of the balancing circuit, which incidentally is done each time the instrument is used, and this consists simply of setting the potentiometer R_5 to give zero meter deflection with the switch S_1 in the "MOD" position.

When using the instrument, it may be found necessary slightly to re-adjust R_5 on account of some R.F. leakage to V_2 and V_3 cathodes and anodes; this must be done with the transmitter unmodulated and with the control R_1 adjusted for minimum input.

The calibrator may now be plugged into jack J on the modulation indicator, and switched on; the switches on both calibrator and indicator should be set to "MOD," and the "SET MOD" control on the calibrator adjusted to produce full scale deflection on the indicator meter. The voltage E required for this is measured on meter M_1. Switches on both units are now thrown to "CARRIER," and the "SET CARRIER" control is set by means of the meter M_2 to a voltage equal to $E\sqrt{2}$. The potentiometer R_4 is now adjusted to produce a half-scale deflection (250 μA) on the indicating meter, and the instrument is now ready for use.

The Instrument in Use

With the switch S_1 set to "CARRIER," the input potentiometer R_1 is adjusted to produce a 250 μA deflection. On throwing S_1 to "MOD," the meter indicates (percentage modulation) ×5 on the microamp scale, i.e. full scale deflection corresponds to 100 per cent modulation. The position of the instrument with respect to the transmitter is not critical, but the minimum input capable of giving the necessary 250 μA deflection should be used to avoid risk of burning out the input potentiometer.

General Points

The calibration of the meter holds for modulation frequencies from below 100 c/s. to 15,000 c/s. Above the latter frequency the meter tends to read low, the error at 20,000 c/s. being some 6 per cent. Variations of mains voltage have little effect on the setting of R_4 a variation of 30 volts does not necessitate rebalancing.

The accuracy of the instrument depends on the accuracy of the original settings. Furthermore, the mains voltage must be sinusoidal, and for this reason, the use of a voltage stabiliser in the supply leads should be avoided.

The calibration is accurate only for sinusoidal modulations.

Although the instrument described operates only in the band 30-60 Mc/s., it is clearly a simple matter to arrange for other frequency coverages by suitable coil design; and if greater flexibility in this sense is required, there is no reason why a plug-in arrangement of coils could not be used.

A High Sensitivity Photo-Electric Cell Circuit

By M. J. TUCKER, B.Sc.*

THE circuit described was developed to detect very small intensities of light fluctuating at frequencies of up to 1,000 c/s. in the presence of some daylight.

The sensitivity obtainable with a photo-electric cell is usually limited in the case of D.C. by amplifier drift, or in the case of A.C. by noise in the photo-cell load resistance. Since a vacuum photo-cell is effectively a source of infinite resistance, both these factors may be improved by using a higher value of load resistance.

Crawford[1] has investigated the factors limiting the value of grid leak which may be used with an ordinary valve, and found that, by carefully choosing the operation conditions, resistances of 100-200 megohms can be used safely with an E.F.36, or if either a cathode follower or a triode circuit with a high anode load be used, this value may be increased to several thousand megohms. Grid currents of the order of 10^{-10} A are still present, however, and their effect would have to be reckoned with in D.C. circuits.

The circuit described may be regarded as being essentially a cathode follower, and will thus be stable with grid leak resistors of several thousand megohms. It has the advantage over the orthodox cathode follower that, as far as frequency response is concerned, the effective grid leak is $R_G \div (1+G)$, where R_G is the actual grid resistor and G the voltage gain of the valve: consequently the flat part of the frequency response characteristic is extended greatly towards high frequencies. Also, in the case of D.C. the output is very suitable for application to a further stage of amplification.

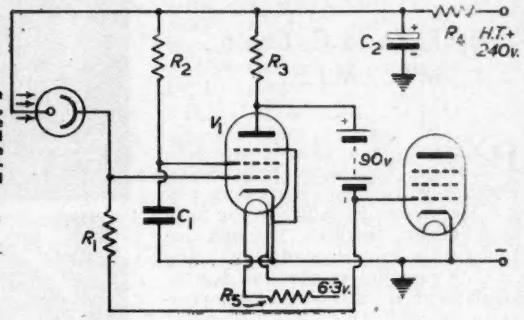
Circuit Details

The circuit as designed for an EF.36 valve is shown in the figure. The drain on the battery is negligible—a small fraction of a microamp—and it is thus possible to use the extremely compact layer-type deaf-aid batteries now available, and these will have practically their normal shelf-life. The "Ever-Ready" batteries type B.123 are in 30-volt units, each of which is approximately 2½ in. by 1⅛ in. by ⅝ in. The author has had one of these circuits in use for two years without replacement of the batteries being necessary.

Sensitive Photocell Circuit

The circuit is shown with direct coupling. For A.C., the second stage should be resistance-capacity coupled from the anode of V_1 in the normal manner. The metallising on V_1 is earthed

R_1	1000 MΩ	R_5	4.7Ω
R_2	680 KΩ ½Wt	C_1	.01 μF
R_3	220 KΩ ½Wt	C_2	2μF 250 V.
R_4	100 KΩ ½Wt	V_1	EF36



If a current i_G injected on to the grid produces a change in anode voltage of V_A and a change in grid voltage of V_G; if R_G is the grid leak resistance (1,000 MΩ in the circuit shown) and G the voltage gain of the valve (taken as positive), then the current through R_G will be

$$\frac{V_G - V_A}{R_G} = i_G$$

but $V_A = -G\,V_G$.

Hence $V_G + G\,V_G = i_G R_G$

and the effective input resistance with respect to earth is

$$R = \frac{V_G}{i_G} = \frac{R_G}{1+G}$$

This is also true for grid current, and hence is another explanation of why a cathode follower will be stable with much higher grid leaks than normally permissible.

The output voltage for low frequencies is given by

$$V_A = -G\,V_G = -i_G R_G \frac{G}{1+G}$$

$$= -i_G R_G \frac{1}{1+1/G} \cong -i_G R_G$$

This, excepting the minus sign which indicates a phase inversion, is the same result as for a cathode follower, and the circuit is, in fact, a cathode follower with the earth and batteries connected in different places. However, the arrangement of grid leak and the connexion of the input between grid and cathode has the effect of *reducing* the input impedance, and, as pointed out above, this reduces the effect of stray capacities between the grid circuit and earth.

It is a basic fact that negative feedback cannot affect signal-to-noise ratio, and hence this and the signal-to-drift ratios will be as if the grid leak were connected between grid and cathode (with a suitable bias). This statement can be checked, of course, by considering the effect of the various sources of noise. The thermal noise produced by a resistor may be considered as a current source in parallel with the resistor, and this current is proportional to $1/\sqrt{R}$. Hence, since G is of the order of 100, a gain in signal-to-noise amplitude ratio of approximately 10 is obtainable with this circuit for a given frequency response characteristic.

The effect of any stray capacity between the anode and grid circuits is increased by the Miller effect, or, to put it another way, is not reduced by the feedback. It is therefore most important that there should be very effective screening between the two circuits.

It is advisable to use sputtered metal rather than carbon resistors for the grid leak.

Vacuum cells are preferable to gas-filled cells for most applications, as they produce less noise, and above the saturation voltage of about 100 volts the sensitivity is practically independent of the potential applied.

* Royal Navy Scientific Service

Reference

[1] "H.F. Pentodes in Electrometer Circuits," by K. D. E. Crawford, *Electronic Engineering*, Vol. 20, p. 227, July 1948.

VISIBLE VECTORS

By F. de la C. Chard, M.Sc., M.I.E.E.*

BY means of a cathode-ray oscilloscope, the phase relationship between voltage and current in any A.C. circuit can be shown in the form of a vector diagram, without disturbing the circuit conditions. The method provides an effective demonstration of voltage-current relationships in inductive and capacitive circuits and shows how such relationships differ for the source of power and the load. Comparison of transformer primary and secondary phase angles, matching of instrument transformers or any indication of phase-angle, not requiring a high degree of accuracy, are simply and rapidly effected.

A single beam oscilloscope is required on which a pair of deflecting coils is mounted, so that its axis can be rotated about the tube. For some applications where greater precision is required, a degree scale is fitted to measure the angle turned through by the coils.[1] Only one pair of deflector plates, the X-plates, are used. The principle is to deflect the beam by means of the coils during one half-wave of current and by means of the deflector plates during one quarter wave of voltage. Fig. 1 shows that, for any phase relationship, it is possible so to choose the periods of current and voltage deflection that they do not overlap. With a lagging current, current deflection occurs from f to h and voltage deflection from c to e. With leading current, deflecting from d to g, it is necessary to use the other quarter wave of voltage, from a to c, to avoid overlap from d to c.

It can be shown that when a cathode-ray beam is deflected simultaneously by two sinusoidal quantities, having a phase difference of θ degrees between them, a circular trace is given when the two axes of deflection are separated by an angle of $(180-\theta)$ degrees. With the voltage axis of deflection fixed, the current coils are rotated until a circular trace is obtained. With this condition, if suitable half-waves of current and voltage are chosen, the angle between the two deflecting traces is the phase angle θ. To make this adjustment of deflecting coil position it was found to be sufficient to put on full wave of voltage with half wave of current. The result, when the two amplitudes of deflection are equal and the coil axis properly set, is a semi-circular trace of the fish-hook form, shown in Fig. 3a and c.

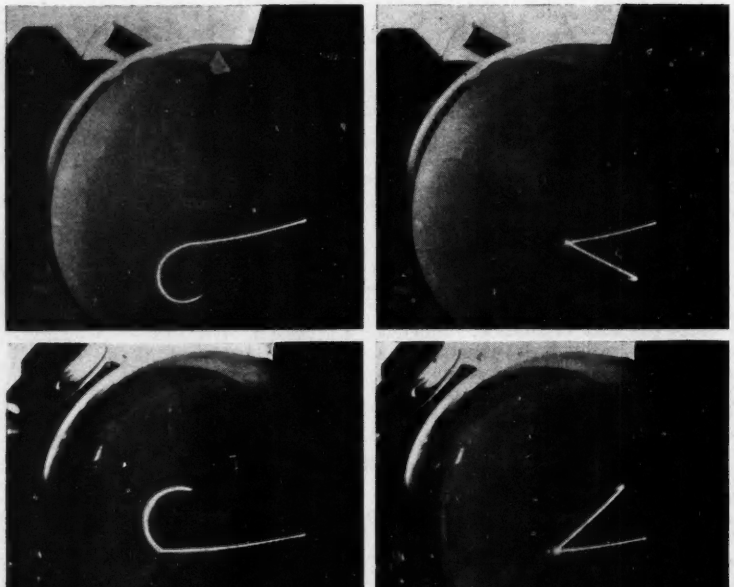


Fig. 3. The Vectors shown on the screen

(a) Setting for coil angle-lagging current (b) Resultant vector diagram
(c) Setting for coil angle-leading current (d) Resultant vector diagram

The current vector on the screen is brighter than the voltage vector, as the spot travels twice to the voltage vector's once

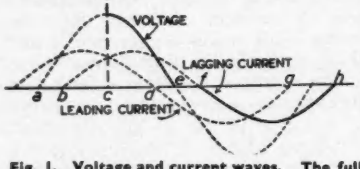
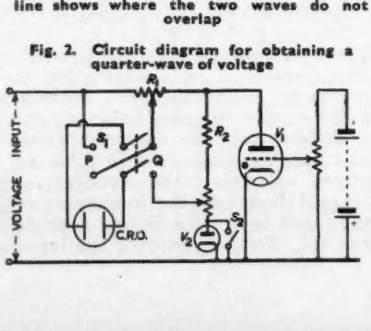


Fig. 1. Voltage and current waves. The full line shows where the two waves do not overlap

Fig. 2. Circuit diagram for obtaining a quarter-wave of voltage



The deflecting coils are connected in the circuit, during the appropriate half period of current, by a synchronous vibrator which connects balancing resistor, of resistance equal to that of the deflecting coils, in circuit during the other half period. If phase-angles of more than 15° are involved, it is necessary to supply the vibrator coil from a phase-shifting network so that the changeover, from current coils to balancing resistor, occurs at the current zero. The circuit for obtaining the quarter wave of voltage is shown in Fig. 2. If the deflecting voltage is taken across the load resistor (R_1) of the gas-filled valve (V_1), the quarter wave c-e (Fig. 1) results. Taking the voltage drop across the resistance R_2 gives the quarter wave of voltage a-c. Closing S_2 gives the complete voltage wave, required to set the current coils at the angle corresponding to the phase angle.

The following three steps show how the method is applied to depict the voltage and current vectors, in

*Merchant Venturers Technical College, Bristol.

their correct phase relationship, for an inductive circuit.

(1) Adjust the vibrator phase so that, with the coil axis vertical, the deflection is all to the left or all to the right of the undeflected spot position.

(2) Put on a full wave of voltage (Fig. 2, S_1 to Q and S_2 closed). Rotate coils and adjust amplitude of voltage deflection until the trace is as Fig. 3a. If current or voltage deflection is not sinusoidal, the resulting figure will only approximate to a semi-circle, but nevertheless a definite best setting of coil angle is discernable.

(3) Put on a quarter-wave of voltage by moving S_1 to P and adjust negative bias on V_1 to give striking at the maximum value of voltage. Fig. 3b shows the resulting oscilloscope picture.

To determine the impedance resistance and reactance, the voltage amplitude is adjusted to make the two lines on the oscilloscope into the hypotenuse and one side of a right-angled triangle. The corresponding input voltage to the circuit of Fig. 2 is measured ($V_{rms.}$). If L_v, L_i and L_x are the lengths of the voltage and current vectors and the distance between their extremities and d_i the coil deflection sensitivity:

$$\text{Circuit impedance } Z = \frac{\sqrt{2}V}{L_i d_i} \text{ ohms}$$

$$\text{Ohms sensitivity } d_o = Z/L_v \text{ ohms/cm.}$$

$$\text{Circuit reactance} = L_x d_o \text{ ohms}$$

$$\text{Circuit resistance} = L_i d_o \text{ ohms}$$

If the circuit is capacitive instead of inductive, the same procedure is followed; the only difference is that the coils are rotated in the opposite sense to give an oscilloscope trace as Fig. 3c, or with quarter wave of voltage as Fig. 3d. If the circuit under test is one in which the direction of power flow can be reversed, the dependence of the vector relationship of voltage and current on the adoption of an input or output convention is well illustrated.[2] With the oscilloscope connexions arranged to give Fig. 3 a and b, with an inductive circuit, reversal of power flow without reversal of current or voltage connections will give Fig. 3 c and d; this shows a current, lagging under one convention, becoming leading under the other.

[1] The Determination of Phase Angle by Cathode-ray Oscillograph. Chard. *J.I.E.E.*, Vol. 83, 1938, p. 681.
[2] Vector Diagrams, Sign and Other Conventions. Robertson. *Elec. Rev.*, Jan, 1940.

High Dielectric Ceramics

NEW ceramic dielectrics having exceptionally high dielectric constants have recently evolved from research by George R. Shelton and Elmer N. Bunting at the National Bureau of Standards.

The unusual electrical properties of naturally occurring titanium dioxide (rutile) have been known for over 40 years and have been useful in radio design for about 20. However, the very high values of dielectric constant of some of the titanates were observed only a few years before the last war. The current investigations have covered a study of the properties of dielectrics prepared by systematic variation in the composition of the alkaline earth titanates, using commercial titania (98.7 per cent. TiO_2) and reagent quality carbonates of barium, strontium, calcium and magnesium. The powdered preparations, moistened with 5 per cent. of a diluted starch suspension, were dry-pressed in the form of disks 3 in. in diameter and ¼ to 1 in. in height, preparatory to calcination. Calcining eliminates most of the carbon dioxide and initiates reactions that affect the properties of the dielectrics.

In the formation of specimens for study, the finely ground calcines were moistened with starch suspension and then pressed at 20,000 lb./sq. in. in hardened steel moulds. The dimensions of the specimens were 0.025-0.10 in. in thickness and 0.25-1.5 in. diameter. In the final heat treatment of the disks the temperatures, ranging from 100° to 150° C. above those for calcination, were maintained for one hour.

The investigations have shown that, in general, the power factor of the specimens increases with increase in content of barium titanates. For example, the power factor for strontium titanate (measured at 1 Mc/s. at 25° C., and with less than 40 per cent. relative humidity) is 0.0001, while barium titanate under the same conditions gives a power factor of 0.01. Measurements made at a frequency of 3,000 Mc/s. indicate a general lowering of the dielectric constant and a poorer figure of merit as compared to the values obtained at one megacycle.

M. LORANT

The Prestopunch

THE home-constructor's problem of cutting circular holes for such items as valveholders, fuses, indicator lamps, etc., in sheet metal and thin plastic sheet has been simplified by the introduction of several types of punch designed for the purpose.

One pattern has a punch, die and separate pilot pin. The die is supported on a solid surface, such as a small anvil, and the punch hammered through. Another type relies on a screw thread to pull the punch into the die. The screw is turned with either an Allen key or a spanner, the thrust being taken on the underside of the screw head and the top of the die.

The screw thread is used in the Prestopunch, but the turning mechanism is a capstan-shaped nut, drilled for a tommy bar, and long enough to reach inside most chassis, while leaving the tommy bar high enough to turn without fouling the chassis sides. Friction has been considerably reduced by using a thrust-race between the capstan-nut and the punch, an improvement that certainly makes the punch easier to use.

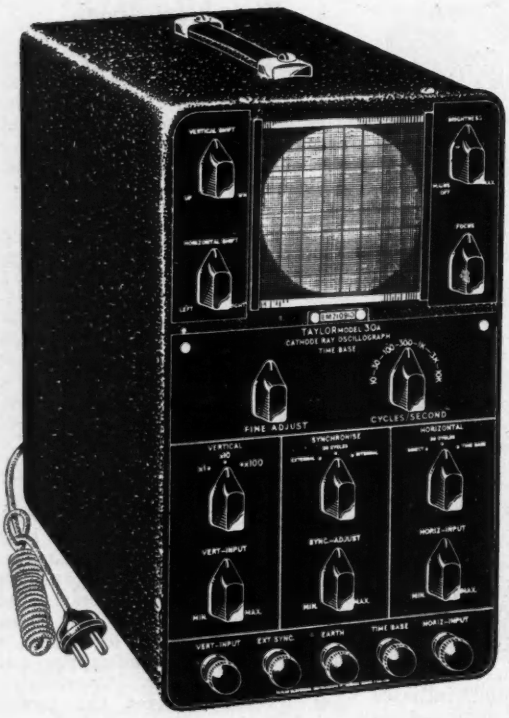
The difficulty of removing the blank from the die after use has been overcome by using a loose punch and die. The punch is forced right through the die and, after use, the punch, blank and die are left loose on the bolster.

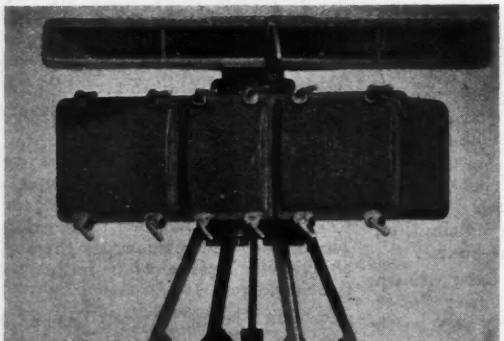
The punch and die, as supplied, are for 1½-in. holes, but a complete range of sizes from ⅝ in. to 1¼ in. by ¼ in. steps has been provided. This makes the set cheaper than an equivalent set of individual punches.

A ⅜-in. screw thread has been used to obtain sufficient strength, and consequently the Prestopunch requires a ⅜-in. clearing hole to be drilled in the chassis. The punch in use upholds the manufacturers' claims for it, and is very satisfactory.

H. MORTON

Prestopunch tools can be obtained from Tele-Radio (1943), Ltd., 177a and 211 Edgware Road, London, W.2, who are the sole distributors. The price is 21s. for the single punch and die. Extra punches are 4s. 6d. each.





Electronic Equipment

A monthly record of British electronic apparatus, components, and accessories, compiled from information supplied by the manufacturers.

Taylor Cathode Ray Oscillograph Model 30A

THE Taylor Model 30A is a general purpose oscillograph incorporating a 3½ inch electrostatic tube. It is designed to give a very wide range of applications, and incorporates a variable-gain vertical-trace amplifier, a variable-frequency time-base generator, and has provision for external coupling to both sets of deflection plates.

The saw-tooth generator using a thyratron valve has a range of 10 to 10,000 c/s with continuously variable frequency control, a 6-position switch and variable resistance giving coarse and fine frequency adjustment. In addition to the saw-tooth generator, provision is made for using the 50-cycle mains supply as a sinusoidal horizontal trace, and it is also possible to use an external source of deflection voltage.

A push-pull amplifier, operating on the input to the vertical deflection plates, is provided. A three-position switch is fitted by means of which relative gains of 1,10 and 100 times may be selected and, in addition, there is a potentiometer which gives continuously variable control from zero to the maximum selected by the switch. The amplifier has a sensibly linear response from about 10 to 30,000 c/s, but is useful up to about 100 Kc/s. It is also possible to make direct coupling to the vertical deflection plates.

There are twelve controls. Four are used for controlling brilliance, focus, and horizontal and vertical shifts ; two—a selector switch and a potentiometer—operate on each of the inputs to the vertical and horizontal deflector plates ; two controls are for the selection of time base frequency. In addition, there are two controls for synchronisation ; one selects the source of synchronising impulses—internal, 50 cycles, or external—and the other is a potentiometer controlling the amplitude of sunchronising voltage to the time-base generator. The on-off switch is integral with the brilliance control which ensures that the instrument is switched on and off under conditions of minimum tube brilliance.

The instrument is operated from A.C. mains 40–100 c/s—three-position mains voltage adjuster at the rear enables selection to be made for 100-120, 200-225, or 226-250 volts. The power consumption is approximately 20 watts.

The overall dimensions are : Height, 12½ in., width, 7½ in. ; depth, 15 in., and the weight is approximately 24 lb. Price : £29 10s.

Taylor Electrical Instruments Ltd.
419-424, Montrose Avenue, Slough, Bucks.

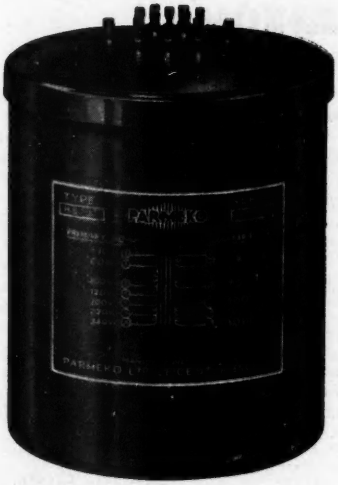
Marine Radar

ON the Promenade deck of Southend Pier a Radar Research Station has been built by Henry Hughes & Son, Ltd. for research work and the instruction of Engineers and Ships' Officers in the use of Kelvin-Hughes Marine Radar equipment.

In addition to the research station an auxiliary display unit has been included in order that the general public may have their first glimpse of Radar in action.

A unique feature of the equipment is the compact mounting of the transmitter/scanner unit in which the aerial is immediately above the transmitter. This is enclosed in a water-tight casing which contains the magnetron transmitter, automatic frequency control unit, aerial turning mechanism, modulator and general power supply unit.

Kelvin and Hughes Ltd.,
107, Fenchurch Street, London, E.C.3.



Hermetically Sealed Transformers

A range of hermetically sealed transformers designed to operate under the most abnormal conditions, and maintain their characteristics when subjected to such wide temperature variations as —40° C. to a maximum working temperature of 100° C, with up to 100 per cent. humidity and to operate up to an altitude of 50,000 feet.

A comprehensive range of transformers and chokes can be accommodated within the seven container sizes already standardised. Models 5088/2 and 3 were developed especially as miniature audio frequency transformers and incorporate internal Mumetal screens which completely enclose an astatically wound coil and core assembly.

Power transformers up to 170 VA. at 50 c/s A. F. Transformers from the miniature input variety up to the 60 watts audio output types and chokes of 20 Henries, 250 milliamps, are within the range immediately available.

Parmeko Ltd.,
Percy Road, Aylestone Park, Leicester.

Midget Electric Motors

THREE types of miniature motor designed for use in control equipment :

1. High resistance split field D.C. motor, with separately excited low voltage armature and direct-coupled feed-back generator. The high resistance fields provide matching loads for high slope pentodes and are operated in opposition, a difference of 2.5 mA causing the armature to rotate. Patt. No. M.10 Mk. 2.

   Dimensions : Overall depth 5⅛ in., height 3¼ in., width 2¼ in. Spindle diam. : 0.218 in.
2. Miniature D.C. motor which can also be adapted as a feedback generator, giving 20 V at 7,000 r.p.m.

   Length 1.75 in., diameter 1.125 in. 6,000 r.p.m. 30 V. Weight 3.2 oz. Patt. No. M.11.
3. Hysteresis type self-starting synchronous motor, 3,000 r.p.m., 3-ph. or single phase with phase-splitting circuits. Overall length 3.25 in., diameter 2.032 in. Patt. No. M.17, Mk. 1.

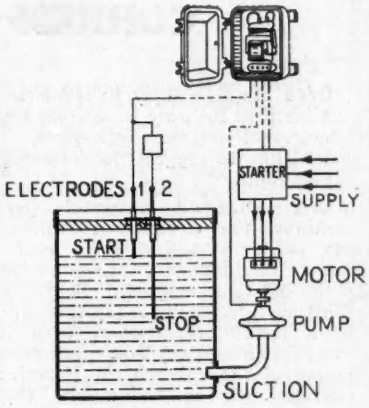
Henry Hughes & Son, Ltd.,
2 Caxton Street, London, S.W.1.

Mains Connectors

THESE connectors are rated at 250 V max. 3-4 amp. and are tested at 1 KV peak. Terminals or tags accept up to 23/36 s.w.g. The type shown is intended for fitting to cabinet back for automatic disconnexion on opening the cabinet.

Details of full range of connectors supplied on request.

A. F. Bulgin & Co., Ltd.
By-pass Road, Barking, Essex.



Floatless Liquid Level Control System

THE Londex " Lectralevel " system is used for the automatic pumping out, pumping in, or maintaining the liquid level in a container. The illustration shows the working principle of the " Lectralevel " system controlling a drainage pump for emptying a sewage container.

The system works without float and if the suction pipe inlet is earthed and used as a common electrode, only one control wire is necessary. The motor starter is controlled by the Londex mercury switch relay type LQA.

Londex Ltd.,
Anerley Works, 207, Anerley Road,
London, S.E.20.

Varistrobe, Type TF906

THE Varistrobe is a small portable A.C. mains-operated instrument for the observation of rotating, reciprocating or vibrating mechanisms in slow or arrested motion. The light source employed is a Neostron lamp in an oscillatory circuit which may either run free, be synchronised with the supply mains, or be synchronised electrically or electro-mechanically with the equipment under investigation. The frequency range is approximately 10-260 c/s. corresponding with speeds of 600-15,600 r.p.m. A special feature of the design is the provision of a phasing control which, when synchronisation is employed, enables the flash to take place at preferred parts of the cycle.

The lamp unit, which is removable for the close inspection of the object under test, is stowed in a compartment at the top.

Dimensions : Approx. 11" high × 7½" wide × 7½" deep, with handle folded.

Weight : 12 lbs. approx.

Marconi Instruments Ltd.
St. Albans, Herts.

CORRESPONDENCE - Residual Hum in Valves

DEAR SIR,—In reply to the letter published in the July issue from Dr. Grey Walter and colleagues, I should like to suggest the following explanation.

Even after all reasonable precautions, the electrode system of the valve in a first stage comes under the influence of either or both of two magnetic fields of "mains" frequency: (a) that due to a mains transformer, even if some feet away; (b) that due to the heater of the valve itself, if mains operated. In connexion with (b), it may be mentioned that a double helix heater gives less magnetic field effect than the more usual W-type of heater. This magnetic field may modulate the electron stream, causing hum, especially if there are magnetic materials forming low reluctance paths within the valve.

Nickel and iron are commonly used in valve electrode construction, and the B-H magnetisation curves of such materials have a very low slope in the region of the origin, and then rapidly increase slope as H is increased from zero. The slope, of course, decreases again towards the saturation value of B. A cyclic variation of H, as from an alternating magnetic field, will cause a cyclic variation of B in the electrode material described by a small hysteresis loop. The extreme points of this loop will lie on the steady state B-H curve just described. If the electrode material is already slightly magnetised, the loop will lie on that part of the B-H curve having appreciable slope, and an appreciable fluctuation of B will result, which may modulate the electrode stream. If the electrode material is now de-magnetised, the loop will lie on that part of the B-H curve near the origin which has very low slope, and a much smaller fluctuation of B will result, insufficient to modulate the electron stream detectably.

N.B. Permeability (equals B/H) may be taken as an indicator of the slope of the B-H curve. As an example, typical silicon steel Transformer iron has an initial permeability of about 400, and a maximum permeability of *ten times* this value.—Yours faithfully,

W. I. HEATH

DEAR SIR,—The letter by Dr. W. G. Walter and Messrs. Shipton and Warren on "Demagnetising Valves as a Cure for Residual Ripple" in the July issue has aroused great interest among valve users. A number have, however, drawn false conclusions, and I would like to draw attention to several points not mentioned in the article.

Measurements were made in our Laboratory on a batch of EF37's including a number of valves rejected because of excessive magnetic hum, and the effect of demagnetisation and magnetisation on the magnetic hum was observed both in triode and pentode connexions.

(All results below, it must be understood, are in the nature of generalisation, as variations between individual valves are large).

(1) Demagnetisation of valves as received produced no improvement. No evidence was found that normal production valves or rejects were initially magnetised.

(2) Magnetisation in various directions produced different results in triodes and pentodes.

(a) In triode connexion the hum often increased very considerably, for example a typical result is:

Magnetic hum, valve unmagnetised
3 μV equivalent

Magnetic hum, valve magnetised
12 μV equivalent,

the hum being expressed as the voltage which, when applied to the control grid, would give the measured hum component in the anode current.

(b) In pentode connexion substantial changes may occur, but such changes were found to be totally random both in magnitude and direction; thus a pentode with an initial hum of, say, 12 μV equivalent may after magnetisation have a hum of 7, 12 or 20 μV.

(3) On demagnetising the magnetised valves they returned to their original hum levels.

As a discrepancy seemed to exist between these results and those of Dr. Walter's, he was approached, and from the ensuing correspondence a probable explanation emerged: as Dr. Walter was using a number of Ticonal magnets in his equipment it was likely that his valves had become magnetised by occasional proximity to these magnets during storage or in handling before use. Furthermore, he was using the EF37 in triode connexion, so that our measurements are in full agreement with the reduction he observed on demagnetisation.

In general, therefore, demagnetisation cannot be considered as a method of reducing magnetic hum in the EF37, unless the valves have previously been accidentally magnetised, and even then consistent improvement can be expected only in the case of triode connexions.

Yours faithfully,

L. H. LIGHT,

VALVE MEASUREMENT AND APPLICATION LABORATORY, MULLARD RADIO VALVE CO. LTD.

DEAR SIR,—Mr. Light's letter contains some interesting information, and one feels that the difference between pentode and triode connexions should be an important clue to the origin of the effects under discussion.

The much higher effective impedance of the valve connected as a pentode would, of course, have an appreciable effect upon all types of hum and noise, but the exceedingly high levels of hum found in some individual valves in this class, suggests that some other effect may be present. Hum levels equivalent to 50-100 μV are not uncommon in pentodes of the EF37 type, and the statistical distribution appears to be far from normal, so that it would seem to be worth while to inquire further into the mechanism whereby heater voltage and current modulate the electron stream in these conditions.

We certainly agree with the final paragraph of Mr. Light's letter, since it would be too much to hope that demagnetisation would be effective if the valve had not previously been magnetised. The fact remains that many valves of the EF37 and other types obtained through various channels are found to be slightly magnetised and demagnetisation of these does reduce the hum level in our amplifiers.

Yours faithfully,

W. GREY WALTER,
H. W. SHIPTON,
W. J. WARREN.

BURDEN NEUROLOGICAL INSTITUTE.

NOTES FROM THE INDUSTRY

R.C.M.F. Exhibition in Stockholm

Organisers of the Exhibition of British components and test gear for the radio and electrical industries at the Kungshallen, Stockholm, are well satisfied with their progress in making Swedish manufacturers and the Services acquainted with all that is available for export in Britain. The Pye television demonstration there had a six-day run during which 10,000 people saw the studio performances. 179,000 watched the reception on sets placed in various parts of the N.K. Stores, Stockholm. The studio audience were also able to watch the performances on the screens of sets placed near the footlights of the stage and facing the auditorium. During the six weeks the Pye team were in Scandinavia some 324,000 people have seen British television in action over the air.

Royal Navy, Electrical Branch S.S. Commissions

The Admiralty announces that it will offer Short Service Commissions in the Electrical Branch of the Royal Navy to former officers of the Torpedo, Special, Electrical, and Air Branches of the R.N.V.R. who were employed on technical duties connected with Radar, Wireless, Air Radio, Air Electrical, or General Electrical equipment. The period of service will be five years on the Active List, to be followed by four years on the Emergency List. Candidates must have completed one year's mobilised service as an officer, and be under the age of 35 on January 1, 1949. They must be medically fit, and must fulfil the normal nationality requirements. Further details are available from and applications should be made to the Director of Naval Electrical Department, Admiralty, Queen Anne's Mansions, London, S.W.1.

Scemco, Ltd.

This company which has specialised in fluorescent lighting and electrical components is to enter the field of electronics. In their showrooms in Soho Street, London, W.1, they are displaying television and other equipment for the amateur constructor, but later on propose to enter the manufacturing and distributing fields of industrial electronics.

"The Ignition of Ignitrons"

Messrs. Hirst Electronic Development, Ltd., have pointed out that the subject of the note on page 350 of the November, 1948, issue of ELECTRONIC ENGINEERING is covered by their pending Patent Application No. 10856 of 1947 having been developed by the author when he was in their employment.

A Modern Home-Built TELEVISOR

ANNOUNCEMENT

3rd Edition

A third edition of the *Electronic Engineering* booklet will be ready shortly and readers who have already placed orders will have copies despatched as soon as they are available.

Wiring Diagram

A detailed wiring diagram has been prepared for less experienced constructors and is now available, price **3s. 9d.**, including postage.

Components

Components additional to those given in the November, 1948 issue as having been approved for use in the *Electronic Engineering* Televisor have now been tested. The full list of such components approved, to date, now reads:—

Scanning Coils
(i) Haynes Radio Ltd.
(ii) Scanco Ltd.

Focus Coil
(i) Haynes Radio, Ltd.
(ii) Porthminster Engineering, Ltd.
(iii) Scanco Ltd.

Line Output Transformer
(i) Haynes Radio, Ltd.
(ii) Scanco Ltd.

E.H.T. Transformers
(i) Haynes Radio, Ltd.
(ii) Partridge Transformers, Ltd.
(iii) Vortexion, Ltd.
(iv) Woden Transformer Co., Ltd.

H.T. Transformer
(i) Gardners' Radio, Ltd.
(ii) Partridge Transformers, Ltd.
(iii) Varley (Oliver Pell Control, Ltd.).
(iv) Vortexion, Ltd.
(v) Woden Transformer Co., Ltd.

250mA and 80mA Chokes
(i) Gardners' Radio, Ltd.
(ii) Partridge Transformers, Ltd.
(iii) Varley (Oliver Pell Control, Ltd.).
(iv) Vortexion, Ltd.
(v) Woden Transformer Co., Ltd.

Correction

In the list issued last month the name "Scanco" was followed by the name "(R.I. Ltd.)", implying that a connexion existed between the two Companies. There is in fact no association between them. Apologies to both for the error.

A Hall-Mark for British Plastics

Certification of plastics is being developed from an agreed scheme between the B.P.F. and the B.S.I. and the Certification Mark illustrated is to be issued for approved plastic materials and products. It is comparable to the Hall Mark on silver and is intended as an independent assurance that the article bearing it conforms to precise requirements laid down by an authority other than the producer.

Sheet and Strip Metal Users' Technical Association

The Annual General Meeting and Winter Conference of this Association is to be held in London on December 9 and 10 at the Waldorf Hotel. Papers are to be given on "Impact Extrusion," "Pressure Welding," "Application of Phosphate Treatment to Wire, Tube, and Deep Drawing, etc." and "Contact Welding." The Association has registered offices at 49 *Wellington Street, Strand, London, W.C.2.*

A.B. Metal Products in Canada

As a result of inquiries received after their display at the 1948 Canadian International Trade Fair a factory for the manufacture of A.B. products is to be opened in Canada. The location of the factory, which will be a fully owned subsidiary of A.B. Metal Products, Ltd., is not yet settled, but negotiations are well in hand.

Mr. L. C. Bray, formerly of C. H. Parsons, Birmingham, has left Luxor Metal and Plastics Ltd., and has joined the staff of Messrs. A.B. Metal Products, Ltd., in the capacity of works manager.

Retirement of Mr. H. A. Price-Hughes

Mr. H. A. Price-Hughes, A.M.I.E.E., manager of the Publicity Department of the B.T.H. Co., Ltd., has retired after 44 years' service with the company. Under his managership the total number of B.T.H. technical publications in current use rose from 55 to over 7,000.

Mr. Price-Hughes is succeeded by Mr. C. H. Chaplain, who joined the company in 1912, and who has been deputy manager of the Publicity Department since April, 1947.

"British Television"

A few copies of the Supplement "British Television," which was issued with this journal in September, 1948, are still available for television dealers who wish to use them for publicising television in displays, etc.

Application should be made to the Circulation Department at the offices of this journal.

The reference to the E.M.I. transmitter which was made in the Supplement is not strictly accurate, since the present television system was developed and the equipment supplied to the B.B.C. by the Marconi-E.M.I. Television Company.

Both the Chelmsford and Hayes laboratories co-operated in this work, and although since the war the two companies have proceeded independently, it is only fair that the part played by the Marconi Company in supplying the equipment should be recognised.

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RADIO TUBE VADE MECUM: 1946 edition, by P. H. Brans. 5s. Postage 6d.

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BOOK

Electronics

By F. G. Spreadbury, (Pitman and Son' 55s. net).

THE author defines "electronics" as the "science and application of the electron." If taken literally, electronics would, according to this definition, include all electrical theory and practice, all electrical engineering, and practically the whole of modern physics. Unless some limitation is imposed, such as that in most electronic devices free electrons are involved, the subject becomes far too wide in scope. Books on "electronics," as the term is generally understood, fall into three categories:—

(1) *Electron physics*, dealing essentially with electron dynamics in vacua and gases.

(2) *Electronic technology*, which covers the theory and design of basic electronic devices.

(3) *Applied electronics* which includes electronic measuring instruments, radio-frequency heating and a vast array of industrial aids.

The preparation of a good book on any one of these three aspects of electronics would be a formidable task in view of the rapidity with which the subject is expanding, but the author of this book has, in 690 pages, attempted to present to the reader "familiar with the principles of the main branches of classical physics" and with a "mathematical standard including the calculus" a balanced view of the whole subject.

Electron physics is covered in 196 pages in Chapters 1 to 4 dealing with the kinetic, quantum and atomic theories, gaseous electrical conduction, electron dynamics, electrons in metals, and photo-electricity; even Einstein's theory is thrown in for completeness. The whole gamut of modern physics is presented cursorily in kaleidoscopic manner from which the average reader will glean "less and less about more and more."

The material on *electronic technology* lies scattered about the book. High vacuum diodes are dealt with in Chapter 8, and triodes, tetrodes, and pentodes in Chapter 10; gas-filled diodes are covered in Chapters 9 and 15 and gas-filled triodes in Chapter 9, phototubes in Chapter 18 (although no actual circuit is given), cathode-ray tubes at great length in Chapters 6, 7 and 17, X-ray tubes in Chapter 5, and electric discharge lamps in Chapter 19. Power rectification is discussed at some length in Chapters 13 and 14, valve amplifiers and valve oscillators cursorily in Chapters 11 and 12 respectively.

Applied electronics is covered in Chapter 16 on Electronic Measuring Instruments and a few words in Chapter 20. Three simple valve voltmeters are described: a somewhat obsolete electronic ammeter, a simple electronic wattmeter and ohmmeter, and a crude temperature θ measuring device.

The reader is left with the impression that electronic devices have been used solely to measure the electrical parameters, voltage, current, resistance, and power. The versatility of electronic devices, the importance of which cannot be emphasised too strongly, has not been considered, and there is no mention at all of the many electronic instruments for measuring capacitance, inductance, frequency, Q, pressure, speed, colour, moisture, turbidity, pH, etc., there is no reference to induction or dielectric heating and only scant reference in Chapter 20 to the cyclotron, betatron and the electron microscope.

At the end of most chapters there is a bibliography, but the manner in which these references have been selected gives the impression that the author is unaware of a vast amount of literature on the subject. There is not a single reference to "Electronics," "Electronic Industries," "Proceedings of the Institute of Radio Engineers," or a single American book; anyone working in this field realises the predominant rôle which such literature has played in the development of the subject. If a bibliography is to be given at all the references should be selected to give a reasonably unbiased picture of the subject; nationalism can go too far.

The index has been compiled in a curious manner: subjects such as the electron microscope, the betatron, cyclotron, triode, diode, voltage regulators, cathode-ray tubes and X-rays do not appear at all, whereas subjects such as "PM6 valve," "Valve B.D.12," "clean-up," and "Q point" leave the seeker in some doubt as to what is to be found in the text: because the author chooses to designate the intersection of two lines in Fig. 11-11 by the symbol Q he must not assume the reader will know this when he is using the index.

The terminology and examples chosen are often quite out of date; for example, the term "specific inductive capacity" is rarely used nowadays, the oscilloscope fully described on p. 587 is an obsolete type, and so also are the triode-pentode and octode circuits on pp. 385 and 386.

REVIEWS

Although well printed with good illustrations, the book on the whole is not well balanced: some subjects are over-emphasised, for example three chapters are devoted to the cathode-ray oscillograph, while other devices of far more importance are not mentioned at all.

There is as yet no other book which claims to cover the whole field, and it is unlikely that one could be written; the author's book is, therefore, unique but unfortunately he has attempted the impossible.

H. A. THOMAS

General Electrical Engineering

By Philip Kemp. 448 pp. Odhams Press. Price 9s. 6d.

IT is somewhat difficult to review a book of this character. The work is represented as being a comprehensive introduction for students, apprentices and all connected with the electrical engineering industry. For students and apprentices (and the latter should also be students) this book surely gives the wrong approach. A student for at least the first two years of his studies should be given the fundamental concepts of electricity and magnetism, the electric and magnetic circuits and the principles of electromagnetic machines. This provides the sound foundation so essential for the proper understanding of the more detailed and specialised studies in the later years of a student's training. In this book, however, the fundamentals are covered in the first chapter of less than 40 pages and a fair proportion of this space is occupied by photographs of machines and apparatus. The succeeding chapters are each more or less self-contained and deal in a descriptive manner with the subjects of generation and transmission of power, installation work, electric motors, utilisation and application of electricity. In addition there are two chapters on telegraphy and telephony and radio communications and television. These chapters are well written and the numerous diagrams and illustrations are commendably clear.

The text gives a very readable survey of the various subjects although the information provided is necessarily somewhat superficial. The majority of the chapters demand a fair technical knowledge on the part of the reader for a proper appreciation.

W. H. D.

Fundamentals of Electrical Engineering

By V. P. Hessler and J. J. Carey. 241 + x pp. McGraw-Hill, Price 21s.

THIS is an important book for the serious student of electrical engineering dealing, as it does, with the fundamental concepts of electricity and magnetism which are here treated in a strictly logical manner. The authors rightly point out that unless the electrical engineer understands clearly the source or basis of each fundamental quantity he will experience difficulty in understanding many of the new problems. In this connexion the authors indicate throughout the text the source of each fundamental relation; i.e., whether it is obtained as a direct result of experiment, definition, derivation, or generalisation. The question of unit systems is treated extensively and the text is written in the m.k.s. system, but all relations are given in general form so that either the c.g.s. electromagnetic or the c.g.s. electrostatic system of units may be applied to any of the relations.

There are some very sound chapters on electric circuits including one on the more complex circuits and one on network theorems—superposition, Thévenin's star-delta, among others. Magnetic fields and circuits are treated in a very thorough manner and there are chapters dealing with transients and magnetostatics.

A large number of searching questions and problems is given at the end of each chapter.

It is of importance to note that the student should possess a prior knowledge of physics and of the integral calculus or should take these subjects concurrently with the reading of this book.

A work which may be confidently recommended to the degree student and to the advanced student in physics.

W. H. D.

"Wireless World" Diary, 1949

Published by Iliffe & Sons Ltd., price 3/4½d. net.

THE reference pages of this diary, now in its 31st year of publication, contain information, mostly technical, of the kind which is useful in the design and maintenance of radio equipment.

The section includes useful formulæ, abacs for coil windings and circuit constants, lists of units, abbreviations, etc., with a number of miscellaneous circuit diagrams. Base connexions for some 400 valves are included.

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BOOK REVIEWS *(continued)*

Electric Contacts

By Ragnar Holm, Ph.D. 398 pages. Almquist & Wiksells Akademiska Handböcker. Hugo Gebers Förlag, Stockholm,

RAGNAR HOLM in the opening words of his preface touches on a fundamental aspect of contact engineering which, while being obvious to engineers and physicists, is seldom fully appreciated. This is that every electrical circuit, however complex or simple, must have in some way an electrical contact associated with it and as such poses a contact problem. In view of this fact it is somewhat regrettable that little pure research or practical development work has been undertaken as compared with that devoted to other fields of scientific endeavour. A fuller realisation of this lack of knowledge should act as a spur to future investigation which in turn should lead to progress in electrical engineering construction of all types.

This book is an excellent example of progressive work in the contact field, representing not only the collective experience and theories of an expert, but also detailed results of his experimental work. The reader will be impressed by the thoroughness of the treatment of each of the four parts into which the book is divided.

Part I covers the theory of stationary contacts, that is contacts in which relative movement does not occur except as a simple opening and closing action, or alternatively as a junction between two conductors in which of course there is no relative movement. From the start Holm attempts to clarify the exact meaning of terms often employed loosely in contact engineering such as, for instance, contact resistance, breaking the problem down to fundamentals and as a result propounding a number of entirely new concepts. Taking as an example contact resistance, a new mode of approach is used covering contact resistance as a function of the construction of the current path due to limited areas of contact rather than the more usual acceptance that contacts of a given size, material and shape, closed under a given contact pressure can be expected to present a given resistance, the value of which can and does lie between wide limits. Holm's work to date may not give a more exact value of resistance to be expected but will undoubtedly have a considerable influence on the design and contour of contacts and of their operating pressures.

It is obviously not possible to consider here all the many factors considered by the author, but it is of interest to note that such widely differing aspects of contact problems such as skin effects, mutual repulsion of symmetrical contacts, the mechanical properties of the contact material, conduction through tarnish and water films and the contact conditions in carbon microphones are dealt with.

The second section of the book deals with sliding and frictional forces involved between contact surfaces. The remainder of the section, an unfortunately small part, deals with the conditions governing conduction through sliding surfaces, of the graphite-graphite and graphite-metal types, special reference being made to commutation and slip rings and a few pages devoted to the special problem of sliding collectors of the type used for overhead power collection and traction equipment.

Probably the most interesting section, at any rate to the practical engineer, is the third, devoted as it is to the phenomena experienced in switching contacts. The treatment of the subject in this section is essentially concerned with the conditions in the contact gap rather than the design of the contacts themselves. The physics of the production of arcs between contacts are considered at length, together with the conditions determining their duration. An excellent treatment is given of arc quenching, together with useful theoretical treatment of the problem of the design of quenching circuits to suit individual applications. The remainder of this section is devoted to material transfer both by vaporisation of the contact materials and by the rupturing of molten bridges. Details of experimental work relating to the assessment of the magnitude of transfer are given, but this unfortunately would appear to be for idealised cases rather than for practical application.

A short and interesting historical section concludes the book, except for an excellent author and literature index and a number of appendices relating to the foregoing text.

One would, in conclusion, like to comment to the effect that excellent as this book is for the theorist and experimental worker it does not unfortunately offer as much useful working data as one could desire to the engineer and designer of switchgear for everyday industrial use. One cannot hope, of course, for both a theoretical treatment and a practical treatment to be complete in one volume, but more attention to practical examples of the theoretical points raised would have extended the usefulness of this book.

Finally a word of congratulation must be given to those who handled the translation into English, as the book is not only an excellent example of English writing but the technical terminology is both clear and concise.

D. O. WALTER

DECEMBER MEETINGS

The Institution of Electrical Engineers

All meetings, unless otherwise specified, are held at the Institution of Electrical Engineers, Savoy Place, London, W.C.2.

Radio Section

Date: December 1. Time: 5.30 p.m.
Lecture: "Fixed Resistors for Use in Communication Equipment, with special reference to 'High Stability' Resistors."
By: P. R. Coursey, B.Sc.(Eng.).
Date: December 14. Time: 5.30 p.m.
Discussion on: "V.H.F. Mobile Radio-Telephone Services."
Opened by: D. H. Hughes.

Measurements Section

Date: December 7. Time: 5.30 p.m.
Lecture: "The Application of the Recurrent Surge Oscillograph to the Study of Surge Phenomena in Transformers."
By: E. L. White, B.Sc.(Eng.) and W. Nethercot, M.A., B.Sc.
Lecture: "An Oscillograph for Automatic Recording of Disturbances on Electric Supply Systems."
By: W. T. J. Atkins, B.Sc.(Eng.),
(This is a joint meeting with the Supply Section.)

Cambridge Radio Group

Date: December 7. Time: 8.15 p.m.
Held at: The Cavendish Laboratory, Cambridge.
Lecture: "Three-Dimensional Cathode-Ray Tube Displays."
By: E. Parker, M.A., and P. R. Wallis, B.Sc.(Eng.).
Hon. Sec.: H. G. Booker, Cavendish Laboratory, Cambridge.

North-Eastern Radio and Measurements Group

Date: December 20. Time: 6.15 p.m.
Held at: King's College, Newcastle-on-Tyne.
Lecture: As Cambridge Radio Group.
Hon. Sec.: G. A. Kysh, Carliol House, Newcastle-upon-Tyne, 1.

North-Western Measurements Group

Date: December 14. Time: 6.15 p.m.
Held at: The Engineers' Club, Albert Square, Manchester.
Lecture: "An Oscillograph for Automatic Recording of Disturbances on Electric Supply Systems."
By: W. T. J. Atkins, B.Sc.(Eng.).
Hon. Secretary: A. L. Green, 244 Brantingham Road, Chorlton-cum-Hardy, Manchester 21.

Northern Ireland Centre

Date: December 14. Time: 6.45 p.m.
Held at: The Queen's University, Belfast.
Lecture: "Analysis-Synthesis Telephony, with special reference to the Vocoder."
By: R. J. Halsey, B.Sc.(Eng.), and J. Swaffield, Ph.D.
Hon. Secretary: J. K. Carrothers, 2 Abbeydale Park, Ballysillan, Belfast.

The Institute of Physics

Electronics Group

Date: December 14. Time: 5.30 p.m.
Held at: The Institute of Physics, 47 Belgrave Square, S.W.1.
Lecture: "Some Limitations of Particle Counting with Electron Multipliers and Geiger Counters."
By: Dr. J. D. Craggs, F.Inst.P.
Date: December 7. Time: 7.0 p.m.
Held at: The University of Glasgow.
Lecture: "Electrical Discharge Tubes."
By: F. G. Heymann.
(This is a joint meeting with Scottish Branch.)
Group Secretary: J. W. Warren, Research Laboratories, The General Electric Co., Ltd., Wembley.

Scottish Branch

Date: December 7. Time: 7.0 p.m.
Held at: The University of Glasgow.
Lecture: "Electrical Discharge Tubes."
By F. G. Heymann.
(This is a joint meeting with the Electronics Group.)
Date: December 8. Time: 7.0 p.m.
Held at: The University of Edinburgh.
Lecture: "Electrical Discharge Tubes."
By: F. G. Heymann.
Hon. Secretary: J. M. A. Lenihan, The University, Glasgow, W.2.

South Wales Branch

Date: December 15. Time: 4 p.m.
Held at: The University College, Swansea.
Lecture: "Recent Developments in Discharge Physics."
By: A. H. von Engel.
Hon. Secretary: Dr. T. V. I. Starkey, Monmouth Mining Technical College, Crumlin, Mon.

British Sound Recording Association

Date: December 17. Time: 7 p.m.
Held at: The Royal Society of Arts, John Adam Street, Adelphi, Strand, W.C.2.
Lecture: "Some Physiological Factors in Quality Appreciation."
By: E. A. Vetter.
Hon. Secretary: R. W. Lowden, "Wayford," Napoleon Avenue, Farnborough, Hants.

The Radio Society of Great Britain

All meetings are held at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2.

Date: December 30. Time: 6.30 p.m.
Annual General Meeting, followed by Discussion on: "420 Mc/s. Work."
Opened by: W. A. Scarr, M.A., and D. N. Corfield, D.L.C.(Tns.), A.M.I.E.E.
Secretary: New Ruskin House, Little Russell Street, W.C.1.

The Television Society

An informal meeting and exhibition will be held at the Cinematograph Exhibitors' Association at 6.30 p.m. on December 29. Visitors are admitted on introduction by a member.

Constructors Group

Date: December 10. Time: 7.0 p.m.
Held at: The Cinematograph Exhibitors' Association, 146 Shaftesbury Avenue, W.C.2.
Lecture: The £15 Television Receiver.
By: L. J. Osborne.

Programme Group

Date: December 7. Time: 7 p.m.
Held at: The Cinematograph Exhibitors' Association, 146 Shaftesbury Avenue, W.C.2.
Lecture: "Getting the Newsreel Story —At Home and Abroad."
By: C. De Jeager.
Lecture Secretary: T. M. C. Lance, 85 Albemarle Road, Beckenham, Kent.

Midlands Centre

Date: December 1. Time: 7 p.m.
Held at: The Chamber of Commerce, New Street, Birmingham.
Lecture: "Studio Technique in Television."
By: D. C. Birkinshaw, M.B.E., M.A.
Hon. Lecture Secretary: Dr. W. Summer, 169 Mary Vale Road, Bournville, Birmingham 30.

Brit. I.R.E.

London Section

Date: December 16. Time: 6.0 p.m.
Held at: London School of Hygiene and Tropical Medicine, Keppel Street (Gower Street), London, W.C.1.
Lecture: "Physical Applications of Microwaves."
By: J. B. Birks.
Secretary: G. D. Clifford, 9 Bedford Square, London, W.C.1.

South Midlands Section

Date: December 16. Time: 7 p.m.
Held at: The Technical College, The Butts, Coventry.
Lecture: "Heating by Centimetric Power."
By: R. Keitley, B.Sc.
Secretary: C. Stokes, 6 Esterton Close, Coventry.

Merseyside Section

Date: December 15. Time: 6.45 p.m.
Held at: The Incorporated Accountant's Hall, Derby Square, Liverpool 2.
Lecture: "Negative Feedback."
By: J. Durnford.
Secretary: J. Gledhill, 283 Portelet Road, Liverpool 18.

ABSTRACTS OF ELECTRONIC LITERATURE

MEASUREMENT

Peak-to-Peak Voltmeter
(F. H. Shepard and E. Osterland)

Pulses and transients of short duration may be measured by an instrument having extremely high input impedance. Pulse-stretching circuits are used and an amplifier feedback arrangement provides substantially zero-impedance output. A full-wave meter rectifier is used so that peak-to-peak values are indicated by the meter. The instrument shown covers a range of 0.001 V to 1,000 V peak-to-peak.

—*Electronics*, October, 1948, p.101.*

A High-Impedance D.C. Valve Voltmeter
(I. A. D. Lewis and K. Firth)

A general purpose electronic D.C. voltmeter is described. Full-scale reflexion is obtained with inputs of ± 25 or ± 250 mV, and the input impedance and grid current values of the order of 10^{10} ohms and 10^{-11} A, respectively. Currents down to the order of 10^{-9} A, (full-scale deflexion) can be measured by externally connecting an input resistor of suitable value. A backing-off circuit is included, and the instrument measures small voltage changes about any value in the range ± 9 V. An accuracy of within 5 per cent. is obtained, apart from drifts in zero setting; the latter may have a value of up to 10 mV.

—*Jour. Sci. Inst.*, October, 1948, p.340.*

The Effect of Waveform on the Accuracy of Rectifier Type Instruments
(A. Cunliffe)

Formulae are derived which show the way in which r.m.s. and full-wave rectifier type A.C. instruments disagree when they are used with a waveform consisting of a fundamental plus an arbitrary harmonic. The formulae show that with worst possible phasing conditions, the disagreement is a first-order effect when the harmonic is odd, and a second harmonic effect when the harmonic is even.

—*Jour. Sci. Inst.*, September, 1948, p.306.*

A Sensitive Capacitance Meter
(D. M. Neale)

The addition of a reactance valve to a crystal oscillator permits observations of capacitance changes of 1 part in 30,000. Possibilities of using the circuit as an input to an amplifier are also suggested.

—*Jour. Sci. Inst.* October, 1948, p.346.

THERMIONICS

The Relationship Between the Emission Constant and the Apparent Work Function for Various Oxide-Coated Cathodes
(H. Jacobs. G. Hees and W. P. Crossley)

Measurements were made of the emission of oxide-coated cathodes on six chemically different metal wires over a period of 500 hours. An empirical emission equation was employed which was found to be as accurate as the conventional Dushman equation and to be simpler to use. It was found that the logarithm of the emission constant A' varied as the sum of the apparent work function times a constant, and the constant B.

—*Proc. I.R.E.*, September, 1948, p.1,109.

Positive-Grid Characteristics of a Triode *(G. W. Wood)*

By operating the grid of a triode at a positive potential it becomes a virtual cathode discharging electrons with uniform initial velocity, and thus a recent theory by Jaffé becomes applicable. The positive-grid characteristics of a number of radio receiving tubes are determined and matched with those determined from theory. Agreement, satisfactory under given conditions, is found in the region of low plate voltages.

Departure of the experimental curves from the theoretical ones is discussed. Practical tubes tested do not, by any means, correspond to the ideal conditions of the theory: the electrodes are not plane; the electrostatic field is not homogeneous; secondary emission from the grid is present; contact potentials exist; and there is always a velocity distribution among the electrons. Nevertheless. the investigation points a way towards a better theory of the triode.

—*Proc. I.R.E.*, June, 1948, p.804.

A New 100-Watt Triode for 1,000 Megacycles
(W. P. Bennett, E. A. Eshbach, C. E. Haller and W. R. Keye)

The design and development of a 100-watt, grounded-grid triode for operation at full ratings up to 1,200 Mc is described. Unusual mechanical design features have been utilised to achieve a tube which not only is capable of excellent performance at ultra-high frequencies. but which can also be manufactured by production-line methods.

Circuit and performance data of this new tube are given.

—*Proc. I.R.E.* October, 1948, p.1296.

TELEVISION

Development of Theatre Television in England
(A. G. D. West)

This paper gives an historical review of the progress of theatre television projection in Great Britain, both before and after the war, and will describe the design and performance of the equipment which has been developed for distribution and projection of television programmes. It will also indicate the proposals now being made for the setting up of a theatre television service in England, first in London, and then throughout the country.

—*Jour. S.M.P.E.*, August, 1948, p.127.

Television Transcription by Motion Picture Film
(T. T. Goldsmith, J. R. and H. Milholland)

The paper describes the electronic and camera equipment for recording television sight and sound on film, the picture made directly from the face of the cathode-ray tube. The application of this technique will be discussed with regard to documentary recording, network syndication use, and theatre television. Representative films recorded in this manner are available.

—*Jour. S.M.P.E.*, August, 1948, p.107.

Automatic Gain Controls for Television Receivers
(K. R. Wendt and A. C. Schroeder)

The general theory of automatic gain controls for television receivers is discussed. Several specific circuits are described in detail with the advantages and disadvantages of each.

—*R.C.A. Review*. September, 1948, p.373.

CIRCUITS

A Low-Noise Amplifier
(H. Wallman, A. B. Macnee and C. P. Gadsden)

This paper describes an amplifier circuit which yields very low noise factor, consisting of a grounded-cathode triode followed by a grounded-grid triode. The combination is entirely non-critical and provides the low noise factor of a triode with the high amplification and stability of a pentode. Noise factors averaging 0.25 db at a carrier frequency of 6 Mc/s. and 1.35 db at 30 Mc/s. have been achieved. Typical circuit details are given.

—*Proc. I.R.E.*, June, 1948, p.700.

* Abstracts supplied by the courtesy of Metropolitan-Vickers Electrical Co. Ltd. Trafford Park, Manchester

Ten transformers
standing in a line,
One had faulty 'innards' -
then there were nine.

Nine transformers -
but one was heavy weight,
No-one could lift it -
so there were eight.

Eight transformers
looking fit for heaven,
One could not stand the cold -
so there were seven.

Seven transformers -
one full of clever tricks,
No-one could understand it -
so there were six.

Six transformers -
one was alive,
Until the 'gaffer' touched it -
then there were five.

Five transformers -
shaken to the core,
One shook down to odds and
ends - so there were four.

Four transformers -
tuned to a 'T',
One struck a false note -
then there were three.

Three transformers
with big jobs to do,
One wasn't up to it -
so there were two.

Two transformers -
all the rest had gone,
One worked but a little while -
leaving only one.

One PARMEKO withstood
every test; so remember
when there's work to do -

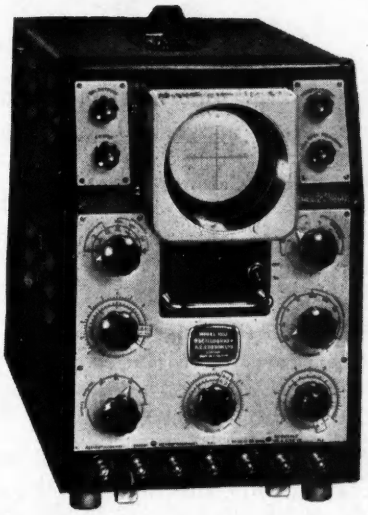
PARMEKO of LEICESTER

Makers of Transformers for Electronic and Electrical Industries

COSSOR

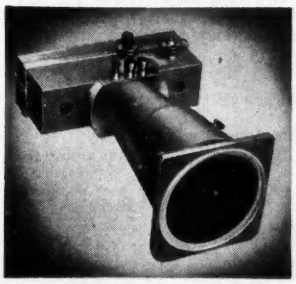
MODEL 1035

DOUBLE BEAM OSCILLOGRAPH



A general-purpose Oscillograph comprising a Double Beam Tube operating at 2 KV., a Time Base, Y Deflection Amplifiers and Internal Power Supplies. The traces are presented over the full area of a flat screen of 90 mm. internal diameter. Signals are normally fed via the Amplifiers and provision is made for the measurement of the applied voltages upon the calibrated Y-Shift Controls. The Time Base operates repetitively or it can be triggered from an external source for single-stroke operation or for continuous scanning at trigger-pulse repetition frequency. A calibrated X-Shift Control is provided for the measurement of Time.

Model 1428 CAMERA



Specially developed for use with Cossor Oscillographs, it provides the simplest means of recording stationary or non-recurrent waveforms and slow transients by the moving film method on standard perforated 35 mm. film or paper. Of robust construction it has provision for power drive by the Cossor Three-Speed Motor Attachment, Model 1429.

Further details obtainable on application to

A. C. COSSOR LTD., INSTRUMENT DEPT. 7, HIGHBURY, LONDON, N.5

Webb's RADIO

for diversity of stock

. . . A few items taken at random from our new 1948 Catalogue

LOUDSPEAKERS (Cabinet Type)

Mordaunt "Duplex" twin-unit, Corner reproducer	98 Gns.
Wharfedale "Corner Cabinet" twin-unit	£48 10
Acoustical Labyrinth "SL15"	£19 10
Sound Sales "Phase Inverter"	£12 10

LOUDSPEAKERS (Chassis Type)

Barker "148," a unit of outstanding merit	£15 15
Wharfedale, in variety—"W10CSB"	£7 0
"Golden"	£3 15
"W12CS"	£7 5
B.T.H. "Senior RK"	£6 15
Goodmans "Axiom Twelve"	£8 8
Vitavox "K12/10" £7 0 0 "K12/20"	£11 0
Rola "G12"	£6 10

THESE ARE SOME OF THE SPEAKERS DEMONSTRATED AND STOCKED AT WEBB'S.

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HIGH FREQUENCY EXPERIMENTATION

We are happy to offer these valves, all new, at very attractive prices. THEY ARE NOT VALVES CULLED FROM BROKEN-DOWN EX-GOVERNMENT EQUIPMENT.

807 ..	7/3	832 ..	25/-	801 ..	8/3
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These valves will be of interest to both the commercial and amateur user—you will never buy them cheaper.

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"Detailed Practical Wiring Diagram," for same, point-to-point connexions, 3/6.

(Send for our component list for this deservedly popular and efficient home constructor's Televisor.)

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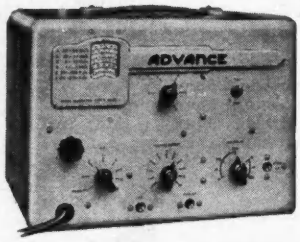
for the TELECOMMUNICATION, RADIO & ELECTRICAL TRADES.
manufactured by GEO. BRAY & CO. LTD. LEEDS 2 ENGLAND.

A "Laboratory" INSTRUMENT... but NOT "Laboratory" Price!

The "Advance" Type E Signal Generator places an instrument of laboratory class within the financial scope of every radio service engineer and experimenter.

The discerning engineer will appreciate its accuracy and stability, its **exceptionally wide range** which covers all frequencies required for radio and television receivers and its accurate attenuating system which enables sensitivity measurements to be made on highly sensitive receivers up to 60 Mc/s. Send for fully descriptive pamphlet.



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Accuracy: Guaranteed within ± 1%
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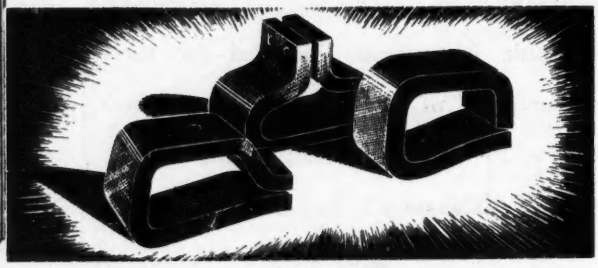

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UNIVERSAL OSCILLOSCOPE

A highly versatile laboratory instrument of outstanding performance

Designed on the unit principle the 'Cintel' Universal Oscilloscope offers a basic instrument which is expandable at will to meet your requirements. Units now available include:

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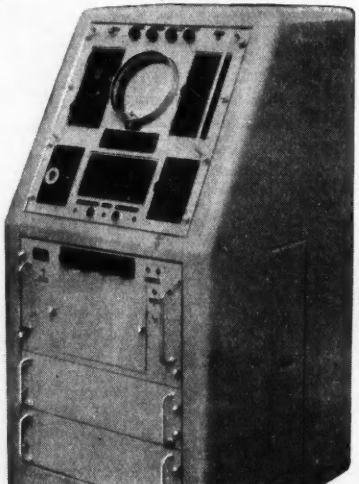

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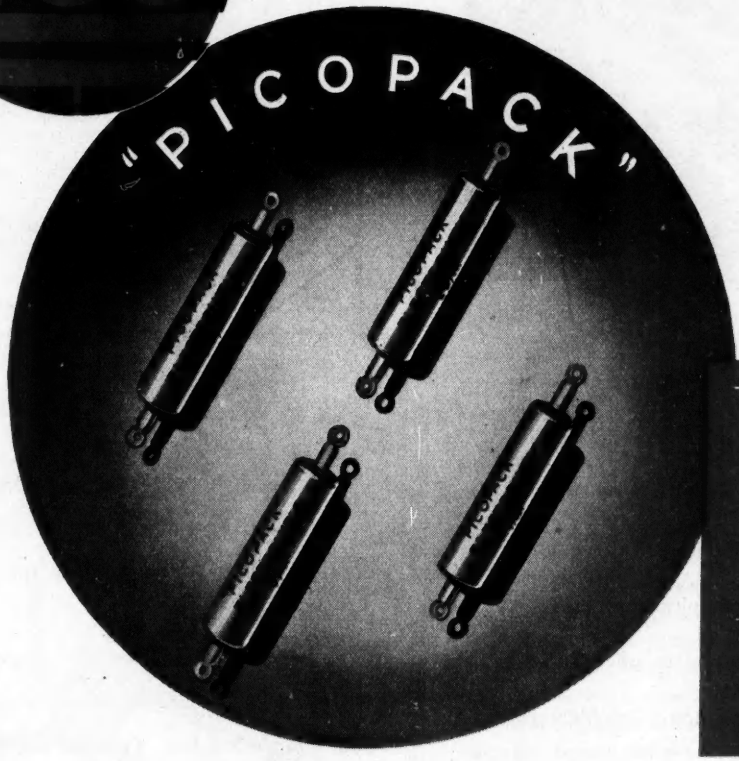
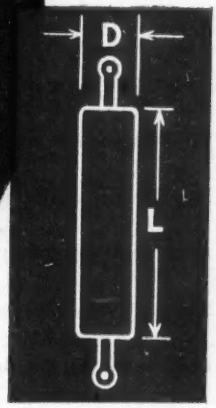
"PICOPACK"





TROPICAL MINIATURES

CAPACITANCE in μF	PEAK W.K.G VOLTS	DIMENSIONS IN INCHES		TYPE NUMBER	LIST PRICE EACH
		Body Length	Diameter		
20	12	1.9/16	0.34	CE30B	2/6
30	15	1.5/16	7/16	CE70B	2/9
10	25	1.9/16	0.34	CE30C	2/6
5	50	1.9/16	0.34	CE30D	2/6
3	100	1.9/16	0.34	CE30E	2/6
2	150	1.9/16	0.34	CE30G	2/6
1	350	1.9/16	0.34	CE30N	2/6

The small dimensions, wide temperature range (-30°C to 71° C), and robustness of these fully tropicalised condensers have proved invaluable to designers of the most compact types of portable apparatus. Like the popular T.C.C. "Micropack" range, they are of all-Aluminium plain foil construction and are hermetically sealed into aluminium tubes by means of neoprene rubber bungs.

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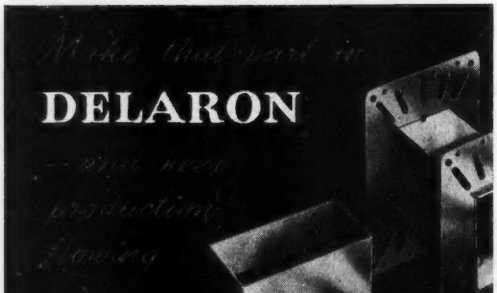
RADIO DIVISION

NORTH ACTON · LONDON · W·3 Telephone. ACORN 0061



Fabricate it or machine it from the wide range of Delaron grades and thicknesses. This laminated synthetic-resin bonded board with its desirable electrical qualities, mechanical strength, pleasing appearance and relatively light weight, offers you not only an answer to a present problem, but many physical and structural advantages as well. The technique of fabricating or machining the material is in no way difficult. Expert technical advisory service freely available.

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The responsibility of a buyer is to buy in the best market. Too often this is interpreted as purchasing from the cheapest source. With resistors this is usually a fatal policy.

Any premature breakdown of equipment can cost more in goodwill than will ever be saved by buying the cheapest resistors. True, the buyer can always change his source of supply but it may be too late to save the good name of his own product.

In the long run it is far cheaper to specify—

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THE new Model L45 " Walkie Talkie " is specially designed to provide reliable and efficient two-way communication over 1-5 miles between sets. This range is greatly increased when used between a mobile or central station and distances of 15-20 miles have been obtained with a clear audible signal.
The Model L45 is but one of the many items of V.H.F. equipment, developed and manufactured by B.C.C. It is the result of many years' experience in the design of Miniature Transportable Communications Equipment.
Other outstanding achievements by B.C.C. in this field are the new Low Power Consumption 4-watt Mobile and the " Handie Talkie."

PRINCIPAL FEATURES OF THE MODEL L 45.

Size 9½ in. by 4 in. by 11 in. Weight 16 lb.
Crystal controlled transmitter and receiver.
Operates on any spot frequency in the range of 75-100 Mc/s. A.M.
On/off and send/receive switches mounted on microphone.
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Strong, sturdy, watertight case.
Approved by the G.P.O. and now in use by the Police and Fire Service.
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Electronic Development and Research Engineers, Contractors to H.M. Government, A.I.D. approved.

It's really quite tiny

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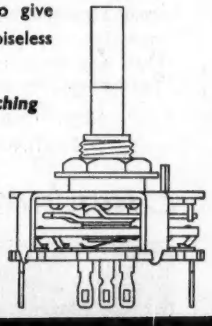
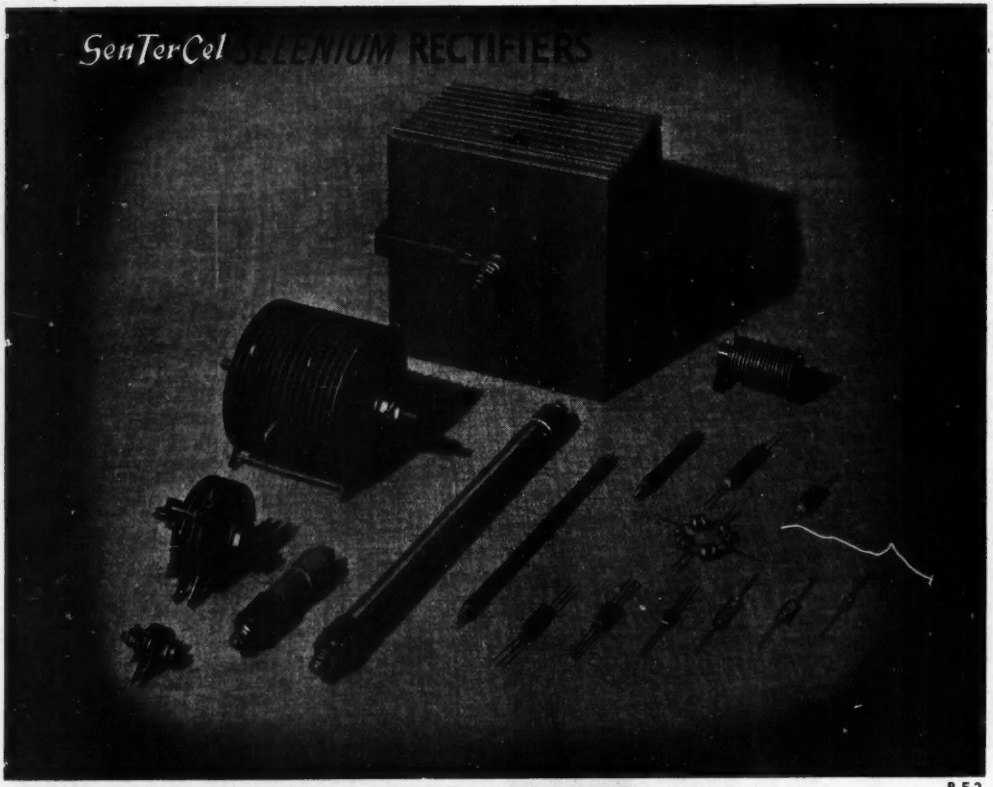
Available in all popular switching combinations.



AB TYPE M-I MINIATURE ROTARY SWITCH

AB Metal Products Ltd., Great South-West Road, Feltham, Middlesex
Hounslow 6256 Feltham 2865

" OAK " WAFER SWITCHES, SINGLE OR MULTI-BANK TOGGLE SWITCHES FOR ALL PURPOSES • PUSH-PULL SWITCHES • ROTARY SWITCHES



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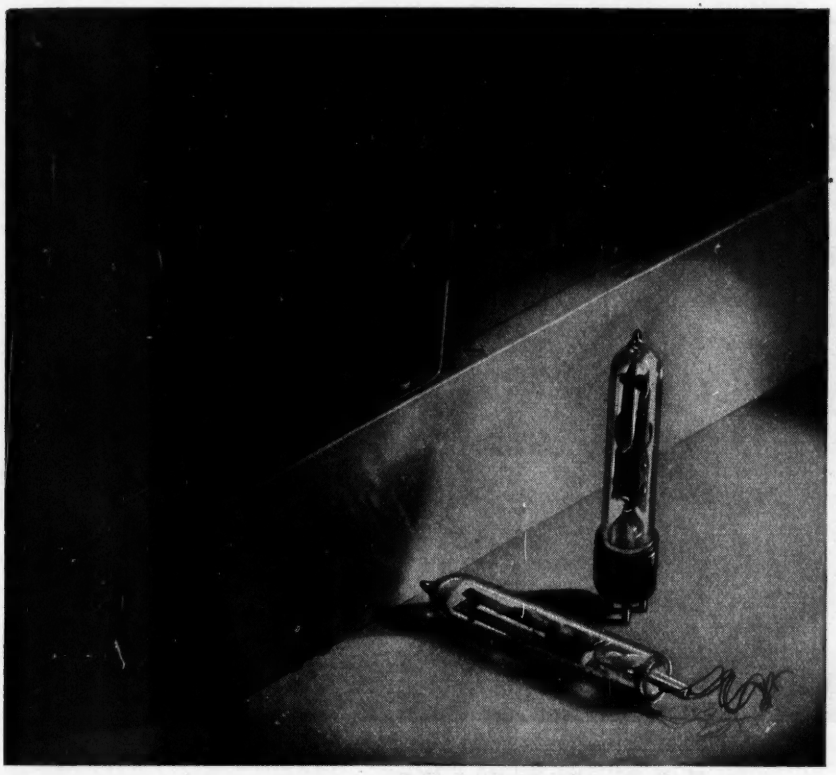

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MINIATURE TIME-DELAY SWITCHES

Reliable, compact, bimetal switches, glass-sealed and evacuated, to operate after a time-delay (such as may be needed to allow valve-filaments to heat-up). The switch operates on 6.3 volts and switches in a maximum of 1 amp. at up to 380 volts AC or 600 volts DC. Time-delay 25 to 100 seconds. Available unmounted (Type 2TQV) or with English miniature 4-pin base (Type 2TQVM). For full specification please write for Publication TV10/16. Other time-delay switches, Publication MS10/16.

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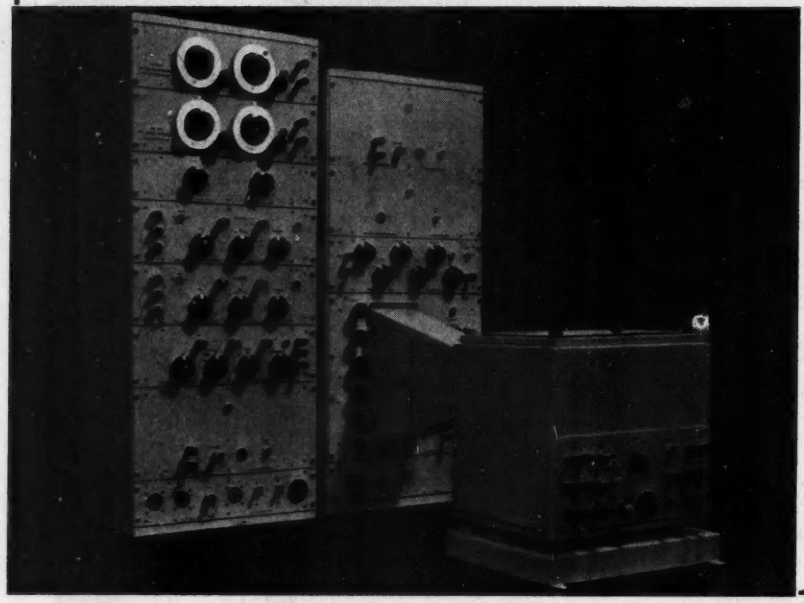

- Single and Multi-channel
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We make a wide range of standard equipments to suit all purposes.

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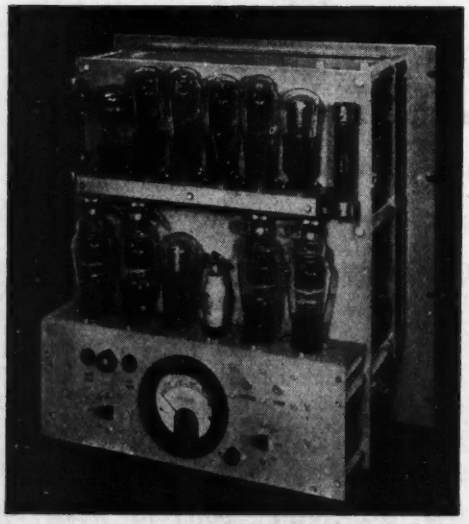

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This forward mounting Rack Unit, illustrated with cover removed, provides a constant output voltage of 300 D.C. at any current up to 600 mA. The output impedance is a fraction of an Ohm, and the residual output ripple is less than 2 mV.

This is only one of the many special Power Supply Units we are making to customers' requirements.

ALL-POWER TRANSFORMERS LTD.
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This three-dimensional model illustrates the expansion properties, over a wide range of temperatures, of iron containing varying amounts of nickel.

The unique properties of these nickel iron alloys make them of importance to designers of temperature-indicating and control devices. For further information write to—

Model by courtesy of J. Stanley Gardner Ltd. (after Chevenard)

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STABLE to 1%

Resistors produced by the cracked carbon process remain stable to ± 1% of initial value.

Tolerances ± 1% ± 2% ± 5%
Low temperature co-efficient.

Welwyn
carbon resistor

WELWYN ELECTRICAL LABORATORIES LTD., WELWYN GARDEN CITY, HERTS
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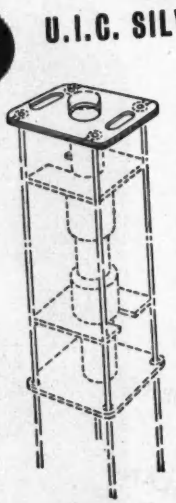
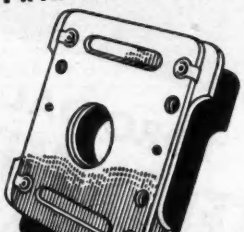
NEW DESIGNS
in the range of
U.I.C
High Stability
CAPACITORS

2 U.I.C. SILVERED MICA TWIN CAPACITORS



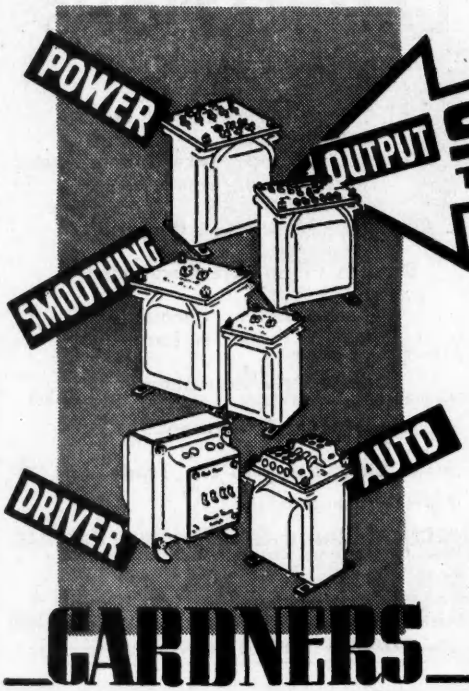
Type SMS. 102 suitable for miniature I.F. transformers ½" square.

Type SMS. 202 suitable for standard I.F. transformers 1¼" square.



This new type Capacitor has been specially developed for use as an end plate or base on I.F. transformers. It forms an integral part of the transformer structure and is connected to the coils during mounting, thereby saving space, materials and the cost of installing two separate capacitors. It also reduces damping arising from eddy current losses induced in the silver layer, inevitable with normal constructions. Modifications to suit individual requirements can be supplied.

UNITED INSULATOR CO. LTD. OAKCROFT RD. TOLWORTH SURBITON SURREY
Telephone : Elmbridge 5241 (6 lines) *Telegrams : Colanel, Surbiton*



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This COMPLETE range will meet ALL your normal needs . .

The requirements of the Electronic Industries are many and varied. It is to meet such demands that the " Somerford " range of Transformers and Chokes exists. No matter whether you are engaged in radio, the manufactur.. of industrial or domestic appliances, or laboratory work, if you are looking for components that will give you accuracy and dependability at an economical cost, you will do well to choose GARDNER products. Research, skill and modern manufacturing methods have been combined to produce components that will withstand the most arduous working conditions and meet the exacting demands of present day standards. The " Somerford " range comprises 141 different types—a type for every normal need.

Ready for IMMEDIATE DELIVERY

Full details and specifications will be sent on request

GARDNERS RADIO LTD.

SOMERFORD, CHRISTCHURCH, HANTS

TELE-RADIO FOR ELECTRONIC EQUIPMENT

VALVES

Mullard New Miniature type in B7G base 6.3 V. heaters	
EY91 half wave rectifier	11/-
EC91 V.H.F. grounded grid triode	30/5
EF92 V.M. RF or IF Pentode	18/3
EF91 high slope, sharp cut off Pentode	21/4
EAC91 diode triode for frequency changing up to 300 Mc/s.	30/5
EB91 screened double diode Separate cathodes	12/10
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ECC91 double triode	30/5

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VR75/30	12/6
VR105/30	12/6
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Mullard V.H.F. Tretrode

QV04/7	25/-

Chromium plated handles, 3 in. centres (pr.)	6/6

WODEN OUTPUT TRANSFORMERS, type H.O.P. 10,000 ohm A to A to 15 ohm secondary. With an additional 15 ohm 10mA feed back winding. Potted type ... 26/3

Valves matched in pairs

PX4 pr. pair	33/-
P27/500 (PX25) pr. pair	45/-
KT66 pr. pair	36/6
6L6G pr. pair	36/6
6V6 pr. pair	25/8

PRECISION CONDENSERS—1% or 2% Accuracy

CM23 100 pF	2/-
CM24 1,000 pF	2/9
SMBM 10,000 pF	7/6

WELWYN HIGH STABILITY RESISTORS

Plus or minus 1%

SA3622 ½-watt	2/-
SA3623 ¼-watt	2/-
SA3634 1-watt	2/6
SA3635 2-watt	3/-

Plus or minus 5%

A3622 ½-watt	8d.
A3623 ¼-watt	9d.
A3634 1-watt	1/-
A3635 2-watt	1/6

WODEN 100-watt auto transformer, fully shrouded ... 21/-

Please include sufficient for Postage and Packing.

The third printing of *Electronic Engineering* " The Home Built Televisor " Now available price 2/6. Also a point to point wiring diagram of the above televisor, price 3/6.

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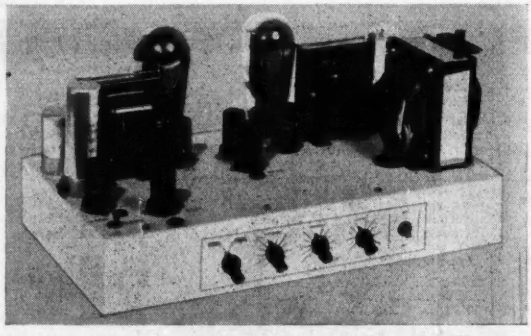

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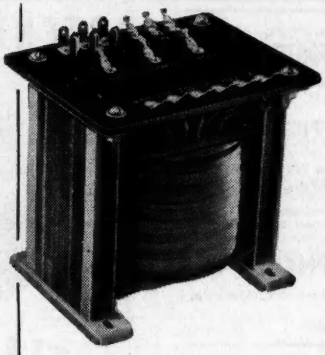

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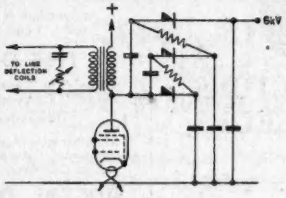

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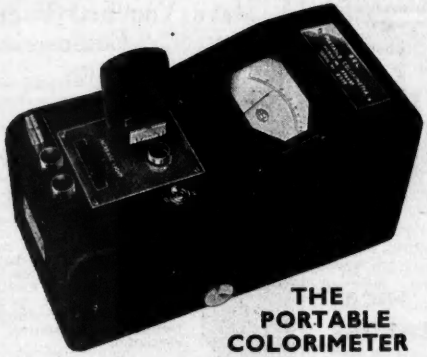

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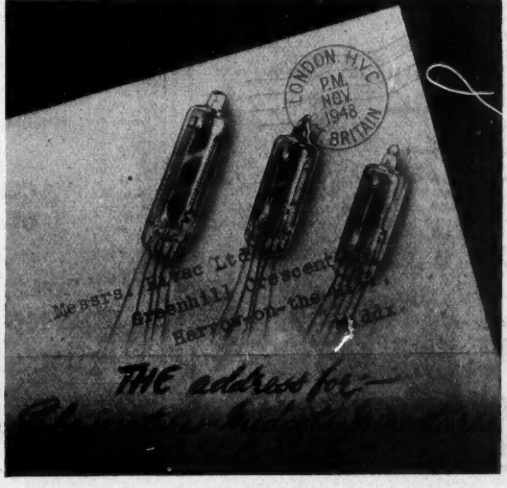

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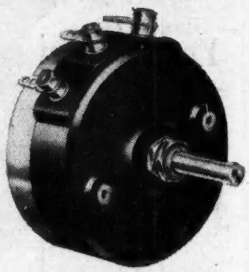

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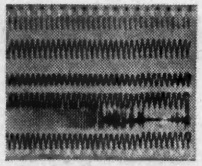

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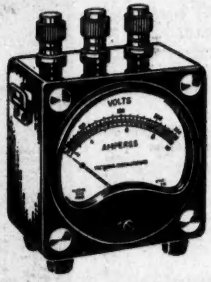

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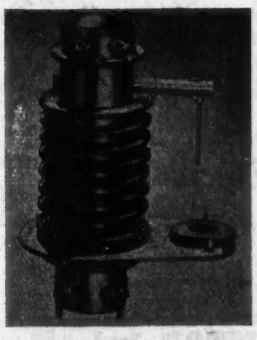

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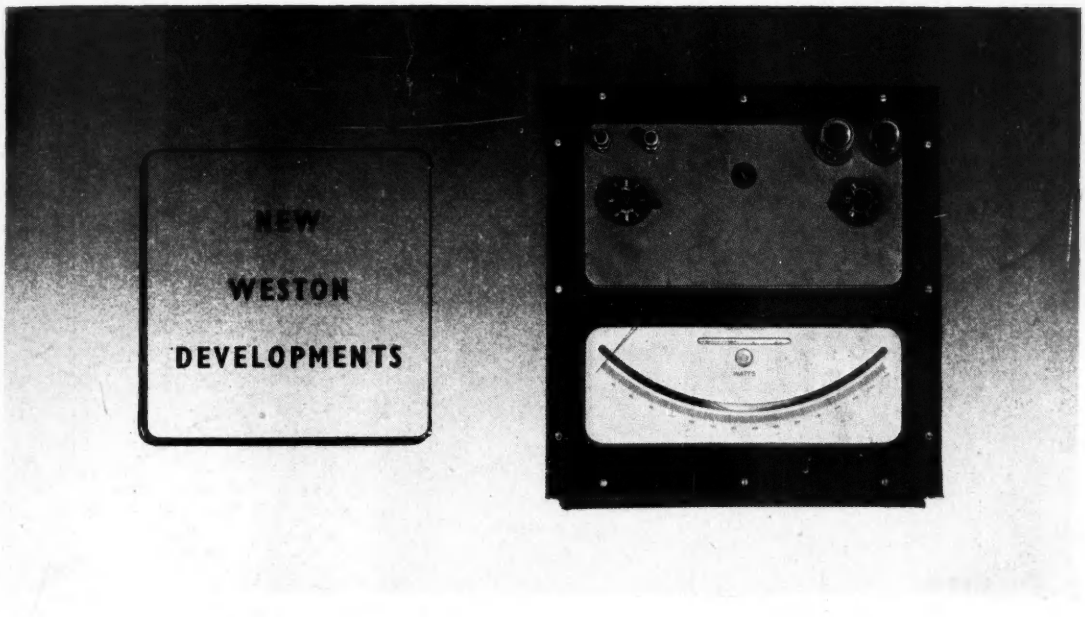

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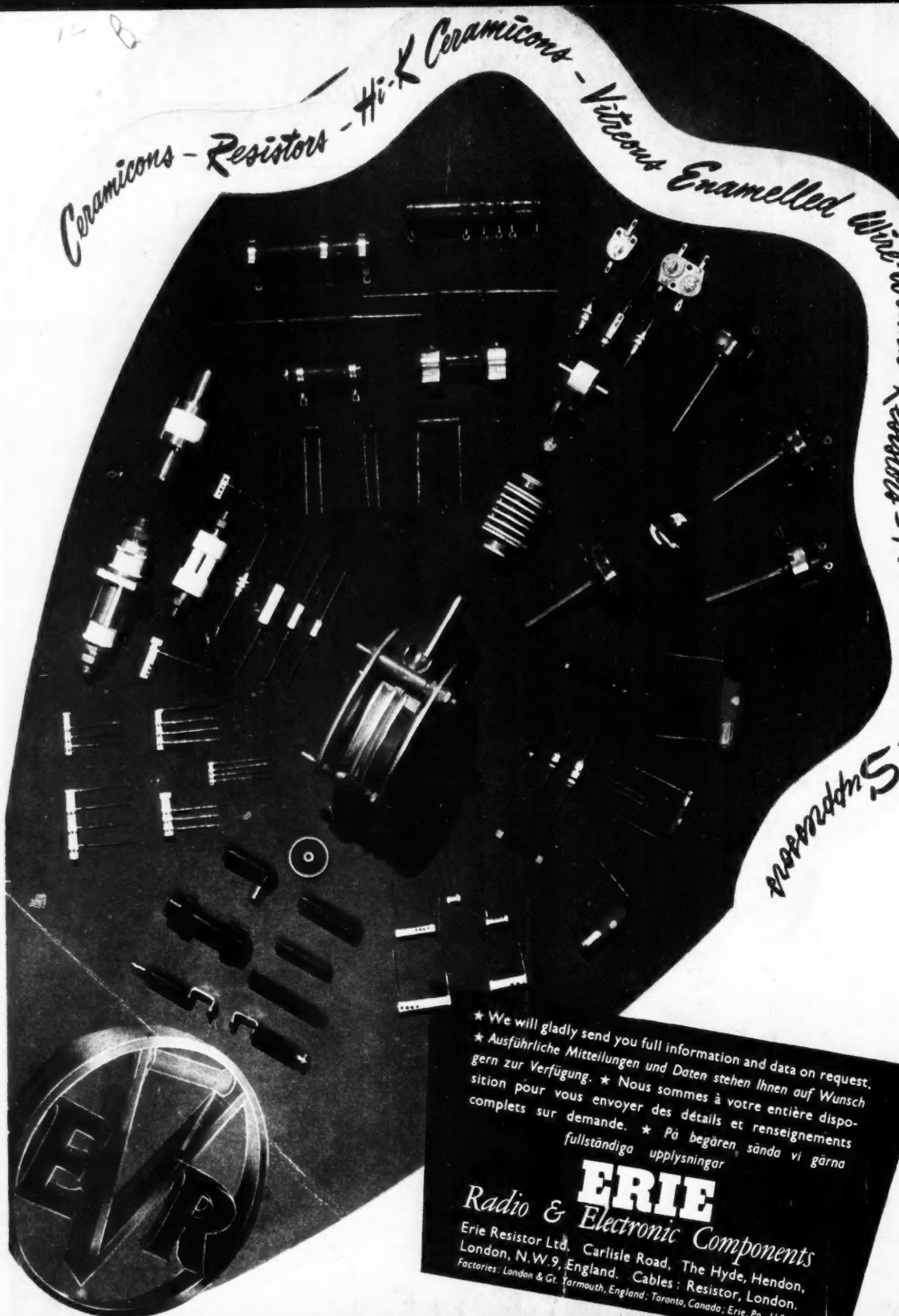

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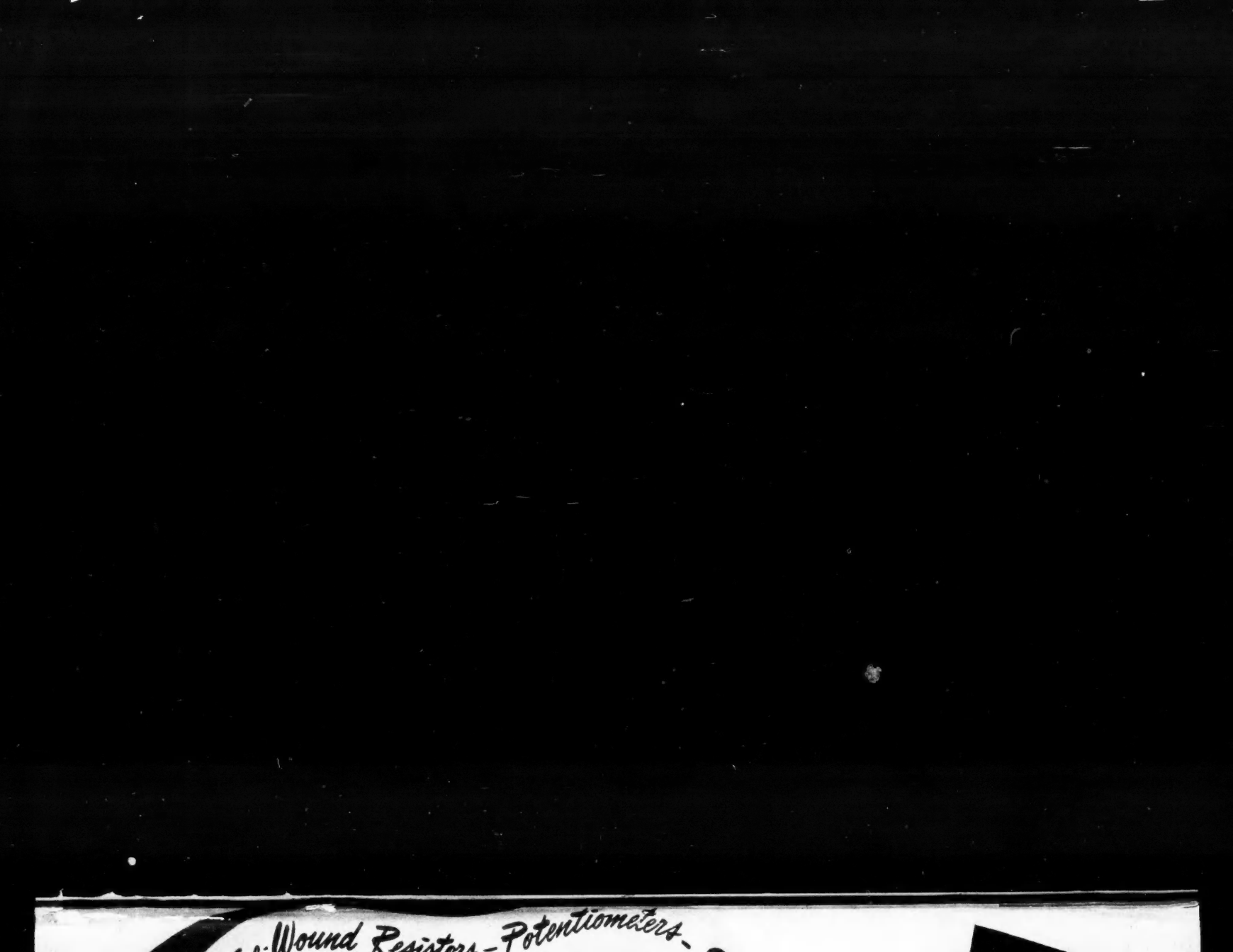
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